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DATE: August 28, 2015

SUBJECT: CARBARYL MITIGATION SCOPING DOCUMENT

Attached is the Carbaryl Mitigation Scoping Document that spans a period of five years (2010 – 2014). Certain data from those years were not yet available when the Department of Pesticide Regulation (DPR) was preparing its 2014 Exposure Assessment Document (EAD) and Risk Characterization Documents (RCD). The attached Scoping Document serves to update the contextual ("scoping") data about carbaryl within DPR's 2014 documents.

The carbaryl RCD concluded that risk estimates potentially were of concern for the following exposure scenarios:

- Occupational handler risks (most short-term, seasonal, and oncogenic risks);
- Occupational re-entry risks (most short-term and oncogenic risks, and some seasonal risks);
- Residential handler and residential re-entry risks (short-term risks for a few residential exposure scenarios); and
- Bystander inhalation exposure from agricultural airblast applications (short-term and oncogenic risks).

Indeed, for some scenarios, oncogenic risk estimates were *more than 1,000 times higher* than DPR's usual negligible-risk standard of one excess cancer incidence per 10^6 individuals.

The updated scoping data show that carbaryl use patterns, labeling restrictions, and illness report rates have remained similar to previous years that were included in the RCD. Therefore, the updated scoping data are consistent with the conclusions of the RCD.

Prior to undertaking mitigation activities, it may be useful for DPR to confirm the values of certain parameters that were used when calculating risk estimates within the RCD. In particular, DPR could confirm:

- dermal transfer coefficients for fieldworkers, which are based on the assumption that fieldworkers do not wear any personal protective equipment (see pages 10-11); and
- concentrations of dislodgeable foliar residues within specific crops (see pages 56-57).

DEPARTMENT OF PESTICIDE REGULATION
Worker Health and Safety Branch, Human Health Mitigation Program

HSM-15004

CARBARYL MITIGATION SCOPING DOCUMENT

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I. Summary

The updated scoping data show that carbaryl use patterns, labeling restrictions, and illness report rates have remained similar to previous years that were included in Department of Pesticide Regulation's (DPR's) Exposure Assessment Document (EAD) (Beauvais 2014) and Risk Characterization Document (RCD) (Rubin 2014). Therefore, the updated scoping data are consistent with the conclusions of the RCD's.

Prior to undertaking mitigation activities, it may be useful for DPR to confirm the values of certain parameters that were used when calculating risk estimates within the RCD. In particular, DPR could confirm:

- dermal transfer coefficients for fieldworkers, which are based on the assumption that fieldworkers do not wear any personal protective equipment (see pages 10-11); and
- concentrations of dislodgeable foliar residues within specific crops (see pages 56-57).

II. Purpose

The purpose of this Scoping Document is to update the contextual ("scoping") data about carbaryl, in order to help guide future mitigation efforts if needed (Salomon and Kelly 2008).

This Scoping Document spans a period of five years (2010 – 2014). Certain data from those years were not yet available when DPR was preparing its 2014 EAD and RCD (Beauvais 2014, Rubin 2014). The Scoping Document serves to update the scoping data about carbaryl in those 2014 documents, including:

- regulatory status,
- use and sales,
- formulations and label requirements, and
- illness reports.

III. Regulatory History / Status

Current regulatory status

Table 1 summarizes some key aspects of carbaryl's current regulatory status, as specified by Salomon and Kelly (2008):

Table 1. Regulatory status of carbaryl as of February 2015.

	Restricted Material	Toxic Air Contaminant	Groundwater Protection List	Proposition 65 List
Yes / No	Yes, except when: 1) formulated as a bait, or 2) labeled only for non-ag uses or for use on livestock or poultry. DPR has no recommended permit conditions.	Yes, because of its status as a Federal Hazardous Air Pollutant within 42 USC 7412 (b) as specified in FAC 14021 (b)	No, though listed in 3 CCR 6800 (b) as having potential to pollute groundwater	Yes (both cancer and developmental toxicity)
Laws	FAC 14001	Determined to be TACs: FAC 14021 (b) and 14023 Potential TACs: FAC 14021(b)	Detected: FAC 13149 Potential to pollute: FAC 13145(d)	HSC 25249.5
Regulations	3 CCR 6400 (e)	Determined to be TACs: 3 CCR 6860 (a) Potential TACs: 3 CCR 6860 (b)	Detected: 3 CCR 6800 (a) Potential to pollute: 3 CCR 6800 (b)	27 CCR Sections 25000 - 27001

FAC: California Food and Agricultural Code
HSC: California Health and Safety Code
3 CCR: California Code of Regulations, title 3
42 USC: United States Code, title 42

Carbaryl is somewhat unusual in that the regulatory status of a given product depends on both:

- the formulation (baits versus non-baits); and
- the labeled use (most agricultural uses, versus all other uses).

This is summarized in Figure 1.

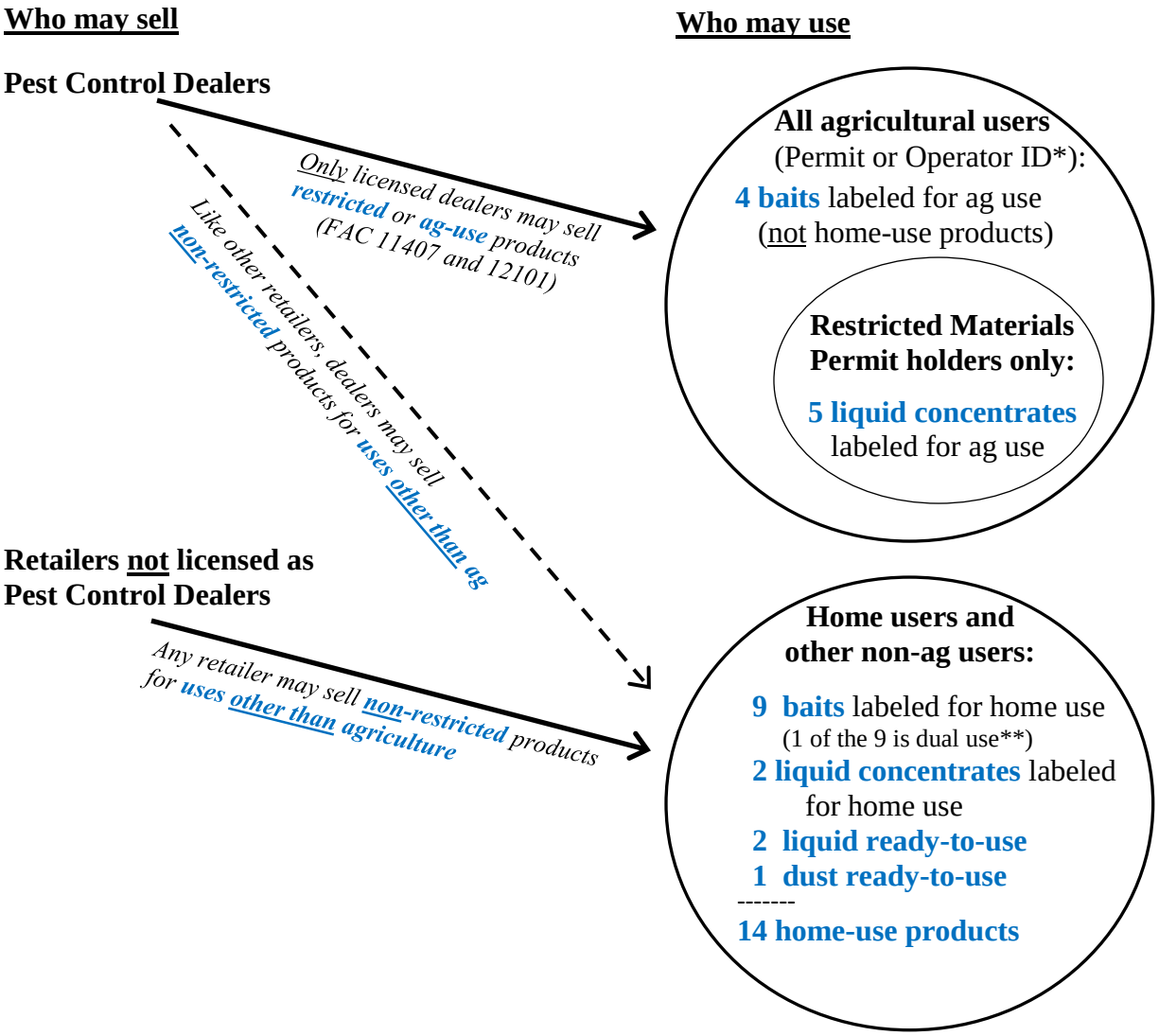
Carbaryl products formulated as baits are excluded from designation as California restricted materials, as specified in 3 CCR 6400 (e). Carbaryl formulations other than baits are designated as California restricted materials, provided that they are labeled for most agricultural uses. More precisely, 3 CCR 6400 (e) exempts carbaryl products that are, "labeled only for one or more of the following uses: use directly on livestock or poultry, home use, structural pest control, industrial use, institutional use, or use by public agency vector control districts pursuant to Section 116180 of the Health and Safety Code." The first exempted use, "use directly on livestock or poultry," is an agricultural use.

Figure 1. Carbaryl products and formulations: who may sell and who may use

Total of 23 products with active registrations as of 6/30/2015:

- **4 baits** labeled for agricultural use,
- **5 liquid concentrates** labeled for agricultural use, and
- **14 home-use products**.

Source of data: DPR 2015d. For product details, see Appendix 2.



* "Operator ID" refers to an agricultural-property-operator identification number issued by a CAC, authorizing the holder to purchase and use non-restricted agricultural-use pesticide products. More information: http://www.cdpr.ca.gov/docs/pur/purovrvw/purovr3.htm

** One bait product (Anderson's) is dual-use: it is labeled for both ag and home use. Dual-use products may be sold for non-ag uses by any retailer (not limited to sale by licensed Pest Control Dealers).

1) Regulatory History / Status (continued)

2014 DPR RCD

DPR's comprehensive RCD for carbaryl (Rubin 2014) was promulgated on December 29, 2014 (Prichard 2014), making it the most recent regulatory document of note. Some key points are summarized below. Page numbers refer to the RCD:

Range of exposure scenarios evaluated by RCD:

- Occupational handlers (pilots, ground applicators, mixer / loaders, etc.);
- Occupational reentry (fieldwork and scouting within agricultural crops);
- Residential handler and reentry, including toddlers (home use on landscape and turf);
- Swimmer exposure (because carbaryl has been detected in California surface waters);
- Bystander exposure from agricultural airblast applications; and
- Dietary exposure, for which the evaluation was largely taken from DPR's 2010 Dietary RCD for carbaryl (Rubin 2010).

Range of hazards and endpoints evaluated by RCD:

- **Acute oral toxicity** (neurotoxicity via cholinesterase inhibition, assessed via a functional observational battery including gait, tremors, and pinpoint pupils). No Observed Effect Level (NOEL): 1 mg/kg (page 114).
- **Subchronic and chronic oral toxicity** (neurotoxicity assessed via inhibition of brain cholinesterase activity). NOEL: 0.5 mg/kg (page 116). Also see "oncogenicity".
- **Acute, subchronic, and chronic dermal toxicity** (neurotoxicity assessed via inhibition of brain cholinesterase activity). NOEL: 14 mg/kg, after adjusting for 70% dermal absorption (page 141). Only one study was available for assessing dermal toxicity, either at the acute or subchronic levels (page 117).
- **Acute inhalation toxicity** (neurotoxicity assessed via inhibition of brain cholinesterase activity). NOEL: 1.0 mg/kg (page 117).
- **Subchronic and chronic inhalation toxicity** (neurotoxicity assessed via inhibition of brain cholinesterase activity). NOEL: 0.5 mg/kg (page 117).
- **Reproductive and developmental toxicity** (including difficult births, miscarriage, low sperm count, and morphologic abnormalities in sperm). The RCD noted that epidemiological studies, "did not make unambiguous associations between exposure and effect" (page 153), and that there were, "caveats in regards to the laboratory animal studies" (page 154). The RCD concluded that it would be reasonable to assume the NOEL for reproductive and developmental toxicity, "would be less than the critical acute NOEL of 1 mg/kg and perhaps less than the subchronic / chronic LED_{10} of 0.5 mg/kg/day" (page 156).
- **Genotoxicity** (mutations and chromosomal aberrations). The RCD concluded, "carbaryl should be viewed as a potentially genotoxic compound" (page 118).
- **Oncogenicity** (induction of tumors). Human oncogenic potency value: 9.72×10^{-3} $mg/kg/day^{-1}$ (page 120).

2014 DPR RCD (continued)

Target levels for acceptable risk used by the RCD (subject to revision by DPR risk managers):

- **Non-oncogenic risks:** "As all of the critical endpoints used in this report were derived from animal studies, the target **Margin of Exposure (MOE) of 100** was considered adequate. It should be noted, however, that an additional uncertainty factor related to possible developmental or reproductive effects was not considered for this document, even though such sensitivities may exist . . . " (page 134). Because an MOE is essentially a safety margin, non-oncogenic risk becomes unacceptable as MOE values grow smaller (indicating less safety).
- **Oncogenic risk:** "**Risk values less than 10^{-6}** (i.e., <1 excess cancer per one million individuals) are considered negligible" (page 134). Because oncogenic risk is expressed as a risk, rather than as a safety margin like MOE, oncogenic risk becomes unacceptable as values grow larger (indicating more risk).

Summary of risk characterization within RCD:

DPR's RCD is notable for estimating oncogenic risk of carbaryl to be several orders of magnitude higher than U.S. EPA's most recent estimates. DPR's Human Health Assessment Branch is preparing a memorandum to explain the methodological differences that led to this lack of agreement (Andrew Rubin, personal communication, 3 February 2015).

For many exposure scenarios and hazards, risk estimates exceeded the target levels. Some sample calculations are shown in Appendix 5. The following summary is copied from page 6 of the RCD:

Occupational handler and occupational reentry risk (dermal and inhalation exposure)

- Short-term exposure: many MOE's less than 100, with several less than 1
- Seasonal exposure: many MOE's less than 100
- Annual exposure: several MOE's less than 100
- Lifetime exposure / oncogenic risk: generally in excess of 10^{-6}, reaching as high as 4.05×10^{-3} for airblast mixer / loaders (handlers) and 1.38×10^{-2} for citrus pruners (reentry workers)

Residential handler and residential reentry risk (dermal and inhalation exposure)

- Short-term exposure: dermal MOE's less than 100 for backpack mixer / loader / applicators and residential reentry onto carbaryl-treated turf (adults and toddlers), inhalation MOE's less than 100 for duster loader / applicator

Toddler risk - hand-to-mouth, object-to-mouth and soil ingestion behaviors

- Short-term exposure: all MOE's equal to or greater than 100

(continued on next page)

Summary of risk characterization within RCD (continued):

Swimmer risk (dermal and oral exposure)

- Short-term, seasonal and annual exposures: all MOE's substantially greater than 100

Bystander risk (inhalation exposure)

- 1-hr exposure: MOE's less than 100 for infants (heavy activity)
- Short-term exposure: inhalation MOE's less than 100 for 1-hr risk (infants, heavy activity), short-term risk (infants and adults)
- Oncogenic risk: 1.81×10^{-6}

2014 DPR EAD

DPR's RCD was based on the exposure assessment presented in DPR's comprehensive Human EAD for carbaryl (Beauvais 2014). The EAD evaluated the range of exposure scenarios and hazards that already have been summarized for the RCD (above). The EAD summarized contextual ("scoping") data for carbaryl through the following years:

- 2009 for pesticide illness and injury data (Beauvais 2014, page 12); and
- 2010 for pesticide use and sales data (Beauvais 2014, page 11).

For other categories of scoping data, such as formulations and label precautions, the EAD does not explicitly state the final year for which data were included.

2011 – 2014 Air Monitoring Network

DPR established the Air Monitoring Network to sample ambient air for multiple pesticides in three communities on a regular schedule. Carbaryl was not included in ambient monitoring in 2011, 2012, or 2013. Monitoring plans for 2014 likewise do not include carbaryl (DPR 2015e).

2011 U.S. EPA Work Plan for carbaryl

In September 2010, U.S. EPA initiated registration review for carbaryl, as required every 15 years under the Food Quality Protection Act (U.S. EPA 2010). In February 2011, U.S. EPA released its Final Work Plan for the carbaryl registration review (U.S. EPA 2011). The Final Work Plan states that U.S. EPA intends to, "require data to conduct updated dietary (including drinking water), residential, occupational, and aggregate human exposure risk assessments" (page 4).

Regulatory history prior to 2011

Regulatory history prior to 2011 is well summarized by Beauvais (2014) and Ruben (2014), and thus is not repeated here.

IV. Pesticide Use and Sales

Carbaryl use and sales have remained similar to previous years that were included in DPR's EAD (Beauvais 2014) and RCD (Rubin 2014). As shown in Figure 2, reported carbaryl use has declined substantially since 2006, but appears to have leveled off in the past few years. In 2013, the most recent year for which statistics are available, total reported carbaryl use was 117,574 lbs active ingredient statewide (DPR 2015a). Carbaryl sales show a similar trend (Figure 2).

As shown in Figure 3, distribution of reported carbaryl use among use sites likewise has remained similar to the years included in DPR's exposure assessment. Most carbaryl use for which Pesticide Use Report records were submitted was agricultural. In particular, during 2011-2013, the most recent years for which statistics are available, applications to tomato crops accounted for nearly 30% of total reported carbaryl use (Figure 3). Tomato, citrus, and olive account for more than 50% of total reported use (Figure 3). Agricultural use of carbaryl includes application to rangeland for grasshopper-suppression programs of the U.S. Department of Agriculture, and applications to nursery stock being held for quarantines against exotic pests.

In addition to reported use, a substantial portion of carbaryl is used for applications that are exempt from pesticide use reporting, namely **non-ag** use of **non-restricted** products by **users other than pest control businesses**, including householders (3 CCR sections 6624 and 6627). The substantial gap between total sales and reported use (Figure 2) gives an indication of the amount of non-reported use. For more information about non-agricultural uses, see Section VI a.

Figure 2. Carbaryl sales and reported use (statewide totals, by year)
Source of data: DPR 2015a, 2015b.

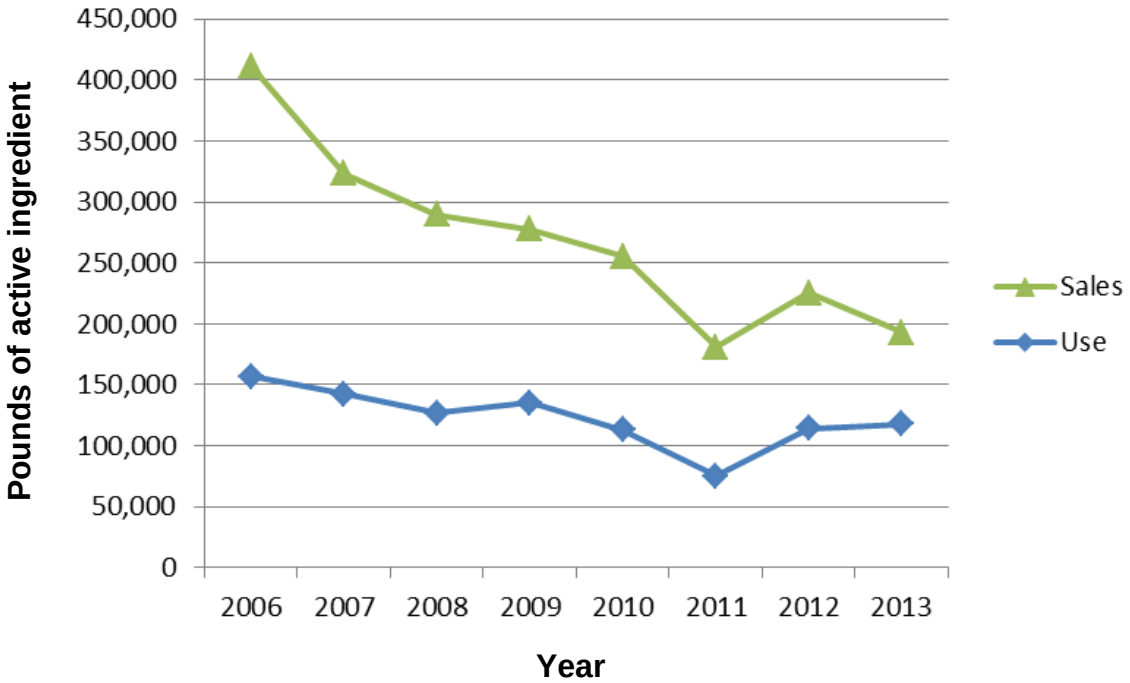
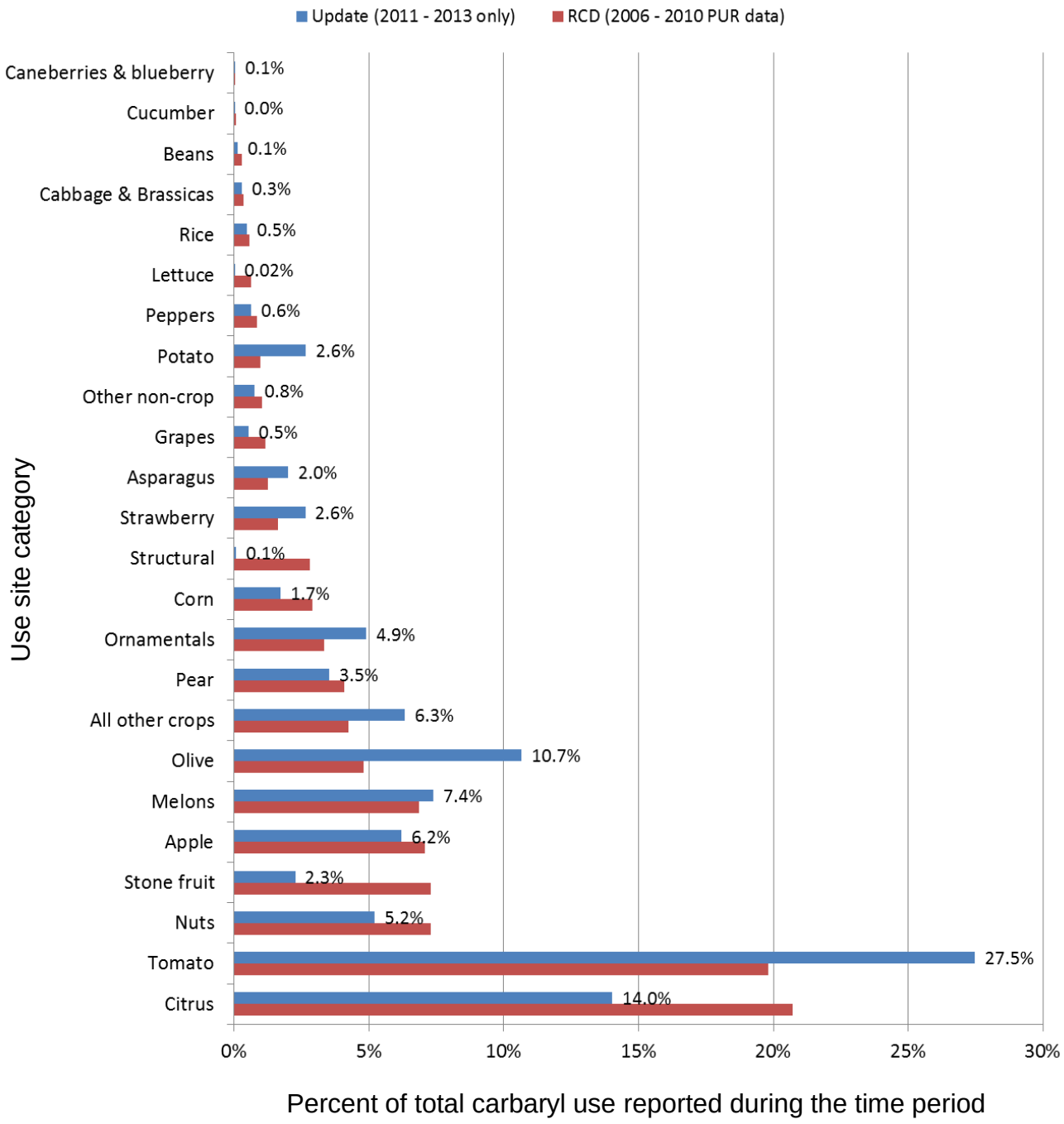


Figure 3. <u>Reported</u> carbaryl use: How distribution among use sites has changed since the RCD. Source of data: DPR 2015(a)



IV. Pesticide Use and Sales (continued)

To help plan mitigation observational activities, Appendix 1 summarizes recent carbaryl use by county and month, as specified by Salomon and Kelly (2008). Most reported use of carbaryl is in counties within the San Joaquin and Sacramento valleys during the months March – August.

V. Products and Formulations

The range of carbaryl products and formulations has remained similar to previous years that were included in DPR's EAD and RCD (Beauvais 2014, Rubin 2014).

As of June 30, 2015 there are 23 carbaryl products[1] with active California registrations. Of these, 21 were reviewed[2] within the EAD (Beauvais 2014). Appendix 2 summarizes the active products, plus three products that were active at the time of the EADt but have since become inactive. As shown in Appendix 2, five of the carbaryl bait products also contain metaldehyde, a molluscicide for control of slugs and snails.

Currently there are two active Section 24c Special Local Need (SLN) registrations for carbaryl:

- SLN CA-780207 (issued October 1978) supplements the labeling for Sevin Brand 4F Carbaryl Insecticide by adding an additional use: control of exotic sucking insects (scales, mealy bugs, and whiteflies) on ornamental nursery stock that is under a hold order or quarantine.
- SLN no. CA-960009 (issued March 1996) supplements the labeling for First Choice Carbaryl Cutworm Bait by adding an additional use: control of European earwig on pricklypear cactus. However, DPR's Registration Branch plans[3] to inactivate this SLN because at the time the SLN was issued, the product (First Choice Carbaryl Cutworm Bait) had EPA Reg. No. 11656-21. The registrant subsequently sold the product, which now has EPA Reg. No. 34704-1021. In addition, the needed use (control of earwigs on cactus) is now included on the product label.

Carbaryl formulations with active registrations comprise:

- Granules, including baits (13 products);
- Liquid concentrates designed to be mixed with water before spraying, including aqueous concentrates, flowables, and suspensions (7 products);
- Liquid ready-to-use formulations (2 products); and
- Dust ready-to-use formulation (1 product).

Figure 1 summarizes the regulatory status of current products and formulations.

[1] Several carbaryl products share the same EPA Registration Number. Nonetheless, each has a unique California registration number. Therefore, this Scoping Document counts each as a separate product, per the policy of DPR's Registration Branch.

[2] Sheryl Beauvais, personal communication, 5 February 2015.

[3] John Inouye, personal communication, 12 February 2015.

VI. Label Requirements

The organization of this section follows the format specified by Salomon and Kelly (2008).

a. Label-approved uses

One or more of the carbaryl products with active registrations allow the following uses:

- *Agricultural* (both *production ag* and *non-production ag)*, including:
  - the crops and use sites listed by name in Figure 3;
  - at least 20 other vegetable, field, and tree crops;
  - forage, pasture, and rangeland;
  - soil and uncultivated land;
  - applications that might be categorized as "regulatory pest control" within Pesticide Use Report data, including grasshopper suppression programs of the U.S. Department of Agriculture and quarantine-related control of exotic sucking insects under the Section 24C registration (Vic Acosta, personal communication, 17 March 2015); and
  - landscape maintenance on non-production-ag sites such as parks, recreation areas, and golf courses (DPR 2014).

In addition, carbaryl is labeled for three categories of non-agricultural uses:

- *Institutional*, including turf and other landscaping of walkways, parking lots, and other areas that are immediately adjacent to buildings such as schools, hospitals, office buildings, libraries, and other institutions (DPR 2014).
- *Home*, namely use in the immediate environment of a household (3 CCR section 6000), application to home vegetable gardens, fruit trees, landscaping, and turf.
- *Structural*, namely perimeter treatments around residences intended to prevent nuisance pests such as earwigs from entering the structure.

The Exposure Assessment estimated that, of the pounds of carbaryl sold during 2010, about 56% was used for non-agricultural uses (Beauvais 2014, page 11).

b. Signal words

All active carbaryl products bear the signal word "Caution," as shown in Appendix 2.

c. Personal protective equipment (PPE)

Perhaps the most important scoping information about PPE is, the RCD calculations that indicated high risks for agricultural fieldworkers assumed that fieldworkers were not using any PPE. Though that worst-case assumption might be appropriate for a RCD, the assumption probably does not match the reality in the field.

Carbaryl labeling does not mandate any fieldworker PPE except for early-entry fieldworkers, which are those who enter a treated field before the expiration of the re-entry interval (REI). Nonetheless, in many crops even the fieldworkers who enter after all REIs have expired routinely wear garments that offer some protection from foliar residues (Miguelino 2014). For

example, strawberry harvesters routinely wear long pants, long-sleeved shirts, cloth caps, and often cloth or leather gloves (Weiying Jiang, personal communication, 3 March 2015).

If DPR risk managers determine that fieldworker risk needs to be mitigated, it would be helpful for those managers also to provide direction on how DPR staff should estimate fieldworker risk: via worst-case assumptions of no PPE, or via actual observations of PPE use by fieldworkers.

Regarding handlers, most carbaryl labeling requirements for PPE have remained similar to previous years that were included in DPR's EAD (Beauvais 2014) and RCD (Rubin 2014). One notable exception is the new home-use product "Orchard Supply Hardware Summer Lawn Food & Insect Control," which does not specify any PPE.

Handler requirements for PPE and engineering controls are summarized in Appendix 3. Note that all carbaryl products labeled for agricultural use state, within the Engineering Controls Statement, "When applicators use enclosed cabs in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for Agricultural pesticides (40 CFR 170.240(d)(5), the handler PPE requirements may be reduced or modified as specified in the WPS."

d. Maximum application rates

e. Maximum number of applications per season

f. Restricted entry intervals (REI)

g. Preharvest intervals (PHI)

Values for these four parameters on carbaryl labeling have remained similar to previous years that were included in DPR's EAD (Beauvais 2014) RCD (Rubin 2014). Current label requirements are summarized in Appendix 4. A few salient points:

- For ag-use products, restricted entry interval for grain sorghum (12 hours) is half that of field corn (24 hours). Perhaps both REI's are adequately protective, but the similar architecture of sorghum and corn crops suggests that both should have the same REI.
- Home-use products allow a wide range of maximum rates and PHIs for a given crop. To mention just one example, for asparagus, labels for various 5% bait products allow maximum rates of 0.75 or 1.0 or 4.0 lb product per 1750 ft^2 ; and labels for liquid home-use products allow spraying asparagus with solutions containing from 0.1% to 0.5% carbaryl. Despite this range, all allow asparagus harvest after a PHI of 1 day.
- The one home-use dust product allows re-entry "once dusts have settled," even for lawn and home-perimeter applications for which use directions recommend leaving a visible layer of dust on surfaces of lawns or soil. This might be an exposure risk for children.

h. Specific restrictions or prohibitions

Again, these have remained similar to labeling from previous years that were included in DPR's exposure assessment (Beauvais 2014) and Risk Characterization Document (Rubin 2014). Nevertheless, for convenience, specific restrictions are listed below:

- **Long REIs** All carbaryl products labeled for agricultural use (both baits and liquid concentrates) stipulate, "When the REI for a crop is 7 days or longer, you must notify workers of the application by warning them orally and by posting warning signs at entrances to treated area."
- **Sprinkler applications** Liquid concentrates labeled for agricultural use, within Directions for Use for Applications Through Sprinkler Irrigation Systems: "Do not apply when wind speed favors drift beyond the area intended for treatment."
- **Airblast applications** Liquid concentrates labeled for agricultural use, within Directions for Use for tree fruits: Drift Management for airblast application sets requirements for deflectors and aiming devices, upward-pointed nozzles, spraying the outside rows, and spraying beyond the edge of the cultivated area.
- **Bee caution** Though not related to human health, use directions include many "Bee Caution" requirements including mowing orchards and avoiding bloom. Therefore, any proposed human-health mitigations should be coordinated with DPR's pollinator-protection efforts.

VII. Potential Exposure Scenarios

The range of exposure scenarios has not changed since DPR's EAD (Beauvais 2014) and RCD (Rubin 2014). As summarized in the RCD, potential exposures comprise:

- Occupational handlers (pilots, ground applicators, mixer / loaders) for both agricultural and non-agricultural uses;
- Occupational reentry (fieldwork and scouting within agricultural crops);
- Residential handler and reentry, including toddlers (home use on vegetable and fruit gardens, landscaping, and turf);
- Swimmer exposure (because carbaryl has been detected in California surface waters);
- Bystander exposure from agricultural airblast applications; and
- Dietary exposure, for which the evaluation was largely taken from DPR's 2010 Dietary Risk Characterization Document for carbaryl (Rubin 2010).

VIII. Pesticide Illness Reports

DPR's Pesticide Illness Surveillance Program (PISP) database uses the following definitions:

- "case" is PISP's representation of a pesticide exposure and its apparent effects on one individual's health (WHS, 2007); and
- "episode" is an incident in which one or more people experience pesticide exposure from a particular source with subsequent development or exacerbation of symptoms. Occasionally, a single episode gives rise to a large number of cases.

For carbaryl, a total of 103 illness cases in 76 episodes were reported during the years 1992 through 2009 (Beauvais 2014). Thus during those 18 years, the average rates of reported illnesses were 5.7 cases/year and 4.2 episodes/year.

Beauvais (2014) did not categorize cases by exposure scenario, but provided the following categorization of carbaryl cases from 1992-2009:

Fieldworker	44
Handler	28
Ingestion	8
Torn packaging	7
Other	16
Total cases	103

In subsequent years (2010 to 2012), annual rates of reported carbaryl cases have been comparable, as summarized in Table 2. However, the distribution of cases among exposure scenarios apparently has shifted, with lower rates for fieldworkers and higher rates for residential handler / re-entry, as summarized in Table 3.

Table 2. Illness / injury Cases and Incidents Associated with Carbaryl, 2010-2012
Source of data: Cal-PIQ database query (DPR 2015c)

Year in which incident occurred	Total cases	Total incidents
2010	1	1
2011	7	3
2012	5	5
Totals	13	9
Average for 3 years:	4.3 cases / year	3.0 incidents / year

Table 3 shows the distribution of these cases among exposure scenarios. Unlike in earlier years, the majority of recent cases were associated with the residential handler / re-entry scenario:

Table 3. Carbaryl Illness / injury Cases by Exposure Scenario, 2010-2012
Source of data: Cal-PIQ database query (DPR 2015c)

Exposure Scenario	Number of Cases
Occupational handlers, agricultural use	1
Occupational handlers, non-agricultural use	
Occupational re-entry (agricultural fieldworkers)	1
Residential handler and re-entry	8 [4 episodes]
Swimmer exposure	
Bystander exposure from agricultural applications	
Dietary exposure	
Other (ingestion, including intentional)	3 [3 episodes]
TOTAL	13

The following summaries of cases from 2010 to 2012 were taken from the corresponding entries in the PISP database (DPR 2015c):

Occupational handler case: A trained applicator was drifted on when he sprayed an insecticide mixture that included carbaryl during an 11-mph wind. He stated he was able to smell an odor through his respirator. He immediately developed symptoms, and sought medical care.

Occupational re-entry case: Plant cuttings were immersed in a mixture of insecticides that included carbaryl, and then mailed to a nursery. While rinsing the cuttings after they arrived, a nursery worker noticed a strong smell. He developed symptoms but continued to work. He sought medical care the next day when his symptoms worsened.

Residential handler and re-entry cases (4 episodes):

1) Family of 5 fell ill after their mobile home was treated by an unqualified applicator hired by the landlord. Applicator used a mixture of insecticides that included carbaryl and others not labeled for use within structures. Applicator was neither certified nor licensed.

The five family members received medical care in several hospitals during 1.5 months of recurring symptoms.

2) On the advice of his taxidermist, a householder tried to control moths by spraying an entire quart of outdoor-use carbaryl product on the preserved animal specimens in his home. After vomiting for two days, he sought medical care.
3) A householder used carbaryl dust on her rabbit hutch to control earwigs. The next day she consulted a doctor, concerned that the symptoms she was experiencing might have been caused by exposure from holding the rabbit.
4) A householder sprayed carbaryl in his back yard. He did not read the label nor use eye protection as specified for overhead applications. He got carbaryl in his eye, and went to the emergency room a few hours later.

Ingestion cases (3 episodes):

1) A woman was admitted to the Intensive Care Unit after intentionally ingesting a 16-oz bottle of carbaryl product that she reportedly purchased from a retail hardware store. She was hospitalized for about a week.
2) In a self-harm attempt, a man ingested several ounces of snail bait containing both carbaryl and metaldehyde. Such baits are labeled for home use. He became ill and was admitted to hospital for overnight observation.
3) A hotel employee became ill after drinking from an iced drink. Several days later, her boss discovered that someone apparently had emptied a bottle of carbaryl insecticide product into the ice machine. The employee developed symptoms and sought medical care.

In summary, 6 of the 13 cases involved home-use carbaryl products, rather than products labeled for agricultural use. Those 6 cases comprised 3 of the residential episodes, and all 3 of the ingestion episodes.

IX. References

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Appendix 1. Reported carbaryl use by county and month of the year ((lbs AI, 2011 -2013). Source of data: DPR 2015a

County	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	County totals
ALAMEDA	<1	1	3	11	2	3	3	4	2	1	4		33
AMADOR								<1					<1
BUTTE	<1	1	8	29	22	29	219	131	10	<1	2	<1	452
CALAVERAS			<1			<1	5	8					13
COLUSA			282	780	384	113	152	880	208				2,800
CONTRA COSTA	11	13	26	543	101	92	220	46	52	3	4	<1	1,111
DEL NORTE										<1	1		1
EL DORADO		<1	3	30	94			7	3			2	140
FRESNO		1,245	7,962	20,543	9,071	5,580	4,772	938	2,693	1,317	38		**54,159**
GLENN	2	400		276	479	29	709	5,440	642				7,977
HUMBOLDT				60	45	26	1	16			16	4	169
IMPERIAL										248			248
INYO			<1	1	19	25		45	<1				89
KERN		170	4,481	9,288	8,939	4,345	296	12,816	124	798	1		**41,256**
KINGS			9,284	11,451	8,880	886	83	786	40		72		**31,483**
LAKE				4	1	1	12	<1	<1	<1			19
LASSEN			4	8		17		20		<1		2	51
LOS ANGELES	576	40	59	153	128	47	53	56	53	33	19	18	1,237
MADERA				285	220	1,097	315	893	32				2,844
MARIN		<1	<1			1	<1		3	1			6
MARIPOSA					76	35	5						116
MENDOCINO				6	27		22	5			5	<1	65
MERCED		1	956	1,719	855	951	2,790	1,428					8,700
MONO					9				1	989			999
MONTEREY	152	584	3,051	4,105	1,174	1,491	654	915	667	1,086	810	1,135	15,823
NAPA		2	<1	4	<1	72	<1	<1		22	<1		100
NEVADA				<1	12	<1	<1				<1		12

(continued next page)

Appendix 1 (cont.) Reported carbaryl use by county and month of the year (lbs AI, 2011 -2013).

County	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	County totals
ORANGE	32	71	168	54	45	29	12	57	70	91	46	17	692
PLACER			<1	16	14	6	12		49	12			108
RIVERSIDE	18	185	28	27	52	82	93	1,023	583	381	77	202	2,751
SACRAMENTO	48	78	1	1,425	467	1,901	3,554	2,290	438	7,571	2,636	<1	**20,411**
SAN BENITO			543	1,210	3,037	1,113	1,639	342	310	<1	<1	9	8,203
SAN BERNARDINO	1	300	2	70	131	81	154	87	7	2	3	<1	838
SAN DIEGO	39	187	49	75	485	408	758	203	147	130	144	46	2,673
SAN FRANCISCO		<1	4		4	2		103					112
SAN JOAQUIN		49	237	5,191	4,445	4,176	3,465	6,630	1,281		636	132	**26,243**
SAN LUIS OBISPO	84	3	6	8	19	71	457	13	5	2	43	1	711
SAN MATEO	125	1	70	45	1	4		2	1	108	183	<1	539
SANTA BARBARA	9	10	1	79	91	138	42	6	8	71	1	<1	456
SANTA CLARA	62	4	32	236	30	136	90	175	80	112	138	137	1,231
SANTA CRUZ		193	247	839	800	125	188	59	21			26	2,497
SHASTA	<1	<1	<1	<1	1	13	146	6	<1		<1		166
SOLANO				1,062	2,274	55		561			1		3,953
SONOMA	<1	1	1	15	71	41	<1	15	1	<1			144
STANISLAUS	151	64	536	2,351	3,294	494	391	883	24				8,189
SUTTER			4	285	413	223	923	2,982	805	327			5,962
TEHAMA					48	370	383	1,441	2,409				4,651
TULARE	31		201	876	2,456	3,162	3,415	4,757	4,831	524	57	53	**20,365**
VENTURA	53	119	325	264	156	3	38	58	556	305	222	6	2,105
YOLO	<1		3,779	5,345	2,471	4,944	1,741	3,407	421	360	<1	<1	**22,467**
YUBA						28	14	903					945
Monthly totals	1,397	3,723	**32,354**	**68,768**	**51,342**	**32,447**	**27,824**	**50,438**	16,576	14,496	5,157	1,792	306,315

Appendix 2. Carbaryl products with active registrations, or that were active as of 2014 Exposure Assessment Document

Product Name	CA Reg. No.	Evaluated in Beauvais 2014	Active as of 6 / 2015	Date inactive	Formulation[a]	CA restrict	Signal Word[b]	Carbaryl %	Metaldehyde %	Most recent label in DPR
10% Sevin Brand Carbaryl Insecticide Granules	34704-289-AA	x		12/31/2012	Granule / Bait	x	C	10.0	0	9/20/2011
Bayer Advanced Complete Brand Insect Killer for Gardens	432-1211-AA-72155	x	x	N/A	RTU		C	0.1	0	3/1/2011
Carbaryl 4L	34704-447-AA	x	x	N/A	F	x	C	43.4	0	12/28/2011
Carbaryl Cutworm Bait [c]	34704-1021-ZA		x	N/A	Granule / Bait		C	5.0	0	3/1/2012
Cooke Pest Granules	8119-5-AA-33116	x	x	N/A	Granule / Bait		C	5.0	2.0	5/5/2010
Corry's Bug Bait [d]	8119-5-ZJ	x	x	N/A	Granule / Bait		C	5.0	2.0	2/10/2010
Corry's Insect Killer [d]	8119-5-ZI	x	x	N/A	Granule / Bait		C	5.0	2.0	10/2/2012
Deadline Bug Bait [d]	8119-5-ZK	x	x	N/A	Granule / Bait		C	5.0	2.0	3/24/2014
Drexel Carbaryl 4L	19713-49-AA	x	x	N/A	F	x	C	43.4	0	9/27/2012
Drexel Carbaryl 5% Bait	19713-627-AA	x	x	N/A	Granule / Bait		C	5.0	0	6/2/2014
First Choice Carbaryl Cutworm Bait [c]	34704-1021-AA	x	x	N/A	Granule / Bait		C	5.0	0	2/17/2011
GardenTech Sevin Concentrate Bug Killer	264-334-AA-71004	x	x	N/A	AC		C	22.5	0	8/25/2011
GardenTech Sevin Garden Bug Killer & Home Perimeter Granules	432-1212-ZB-71004	x	x	N/A	Gran		C	2.0	0	2/28/2012
GardenTech Sevin Lawn Insect Granules	432-1212-AA-71004	x	x	N/A	Gran		C	2.0	0	12/9/2011
GardenTech Sevin Ready-To-Spray Bug Killer	264-334-ZA-71004	x	x	N/A	AC		C	22.5	0	8/25/2011
GardenTech Sevin Ready-To-Use Bug Killer	432-1211-ZA-71004	x	x	N/A	RTU		C	0.1	0	8/15/2011
GardenTech Sevin-5 Ready-To-Use 5% Dust	432-1209-ZA-71004	x	x	N/A	Dust		C	5.0	0	2/16/2012

(continued next page)

Appendix 2 (cont). Carbaryl products with active registrations, or active as of 2014 Exposure Assessment Document

Product Name	CA Reg. No.	Evaluated in Beauvais 2014	Active as of 6 / 2015	Date inactive	Formulation[a]	CA restrict	Signal Word[b]	Carbaryl %	Metaldehyde %	Most recent label in DPR
Orchard Supply Hardware Summer Lawn Food & Insect Control	8378-31-AA		x	N/A	Granule / Bait		C	4.3	0	4/4/2013
Ortho Bug-Geta Plus Snail, Slug & Insect Killer	239-2514-ZC	x	x	N/A	Granule / Bait		C	5.0	2.0	12/16/2011
Prokoz Sevin SL Carbaryl Insecticide	432-1227-ZA-72112	x		12/31/2014	AC	x	C	43.0	0	11/3/2009
Sevin 5 Bait	2935-366-ZA	x	x	N/A	Granule / Bait		C	5.0	0	6/24/2011
Sevin Brand Technical	264-324-ZH	x		12/31/2012	Powder		W	99.5	0	3/18/2010
Sevin Brand 4F Carbaryl Insecticide	264-349-ZB	x		12/31/2014	F	x	C	43.0	0	1/26/2011
Sevin Brand 4F Carbaryl Insecticide	61842-38-AA		x	N/A	F	x	C	43.0	0	2/1/2013
Sevin Brand XLR Plus Carbaryl Insecticide	264-333-ZC	x		12/31/2014	S	x	C	44.1	0	1/27/2011
Sevin Brand XLR Plus Carbaryl Insecticide	61842-37-AA		x	N/A	S	x	C	44.1	0	2/1/2013
Sevin SL Carbaryl Insecticide	432-1227-AA	x	x	N/A	S	x	C	43.0	0	4/29/2010
The Andersons Professional Turf Products 8% Granular Insecticide with Carbaryl	9198-146-ZB	x	x	N/A	Granule / Bait	x	C	8.0	0	11/1/2011
Total active products as of 6/30/2015 [c, d]			23							

Notes

a Formulations: AC = aqueous concentrate; F = flowable; RTU = ready-to-use liquid; S = suspension

b Signal words: C = caution, W = warning

c "Carbaryl Cutworm Bait" and "First Choice Carbaryl Cutworm Bait" are alternate brand names; both share the same EPA Reg. Number. Nonetheless, DPR classifies them as two separate products.

d "Deadline Bug Bait" and the two "Corry's" products are alternate brand names.

Appendix 3. Handler safety requirements on carbaryl labeling[a] as of February 2015.
Source of data: registered labeling on file with DPR's Registration Branch as of Feb. 2015

Type of product and use (as summarized in Figure 1)		PPE or engineering controls required for:		
		Mixers / loaders	Applicators	Flaggers[b]
Carbaryl products labeled for agricultural use				
Baits (4)	Ground	Long-sleeved shirt, Long pants, Shoes plus socks, C-R gloves		N/A
	Aerial applications	As above, plus dust/mist filtering respirator	Pilots: as above, plus enclosed cockpit	As above, plus enclosed cab
Liquid concentrates (5)	All applications (minimum), including ground and sprinkler	• Long-sleeved shirt and long pants • Shoes plus socks • C-R gloves • C-R apron	• Long-sleeved shirt and long pants • Shoes plus socks • C-R gloves	N/A
	Chemigation	As above, plus dust-mist filtering respirator	As above	N/A
	Aerial applications	As for chemigation	Pilots: As above, plus enclosed cockpit	As for citrus airblast applicators
	Airblast, open cab, rate of 5 lbs AI / acre or higher	No extra requirements: • Long-sleeved shirt and long pants • Shoes plus socks • C-R gloves • C-R apron	• Coveralls over long-sleeved shirt and long pants • C-R gloves • C-R footwear plus socks • C-R headgear • Dust-mist filtering respirator	N/A
	Airblast, citrus or wide-area mosquito adulticide applications	No extra requirements: • Long-sleeved shirt and long pants • Shoes plus socks • C-R gloves • C-R apron	• Enclosed cab approved for dermal protection • Long-sleeved shirt and long pants • Shoes and socks • Dust-mist filtering respirator, or enclosed cab approved for respiratory protection	N/A
Carbaryl products labeled for uses other than[c] agriculture				
Baits (9)	Ground	Long-sleeved shirt, Long pants, Shoes plus socks, C-R gloves. Exceptions: Orchard Supply has no PPE, and Ortho Bug-Geta says "protective" gloves rather than C-R.		N/A
Liquid concentrates (2)	Ground (pump or hose-end sprayer)	• Long-sleeved shirt and long pants • Shoes plus socks • "Household latex or rubber gloves" • For overhead applications, also wear a hat and eye protection		N/A
Liquid ready-to-use (2)	Ground	As for liquid concentrates		N/A
Dust (1)	Ground (container is ready-to-use shaker)	"Household latex or rubber gloves"		N/A

Appendix 3 (cont.). Handler safety requirements on carbaryl labeling[a] as of February 2015.

Notes:

C-R = Chemical-resistant, USEPA Category "A"

a In addition to labeling requirements, California regulations (3 CCR 6738) require most employees to wear eye protection and gloves when handling any pesticide.

b Though labeling allows flaggers in some situations, California aerial applicators no longer use human flaggers (CA Agricultural Aircraft Assoc., personal communication).

c One bait product (Anderson's) is dual-use: it is labeled for both ag and home use.

Appendix 4. Application limits, REIs, and PHIs for carbaryl products, February 2015

Type of Product and Use[a]	Max. rate per application (lbs carbaryl AI per unit area)	Min. retreatment interval	Max. no. of applications per season	REI (re-entry interval)	PHI (before harvesting or grazing)
Carbaryl products labeled for agricultural use					
Baits (4 products):					
Asparagus, preharvest	1.0 lb / acre	3 days	3 preharvest	12 hours	1 day
Asparagus, postharvest	2.0 lb / acre	3 days	5 pre- and post-harvest combined	12 hours	N/A
Brassica vegetables, head and stem (Sub-Group 5 A)	2.0 lb / acre	7 days	3	12 hours	3 days
Brassica vegetables, leafy greens (Sub-Group 5 B)	2.0 lb / acre	7 days	3	12 hours	14 days
Cucurbit vegetables (Group 9)	1.0 lb / acre	7 days	6	12 hours	3 days
Fruiting vegetables, Group 8	2.0 lb / acre	7 days	4	12 hours	3 days
Root and tuber vegetables, Group 1 (except sugar beets and sweet potatoes)	2.0 lb / acre	7 days	3	12 hours	7 days
Sugar beets	1.5 - 2.0 lb / acre	14 days	2	12 hours	7 days
Edible leaves of root and tuber vegetables (beet and turnip tops)	2.0 lb / acre	7 days	3	12 hours	14 days
Sweet corn[c]	2.0 lb / acre	3 days	3 (or 8 for Sevin 5 Bait)	24 hours (21 days for detasseling)	Hand harvest prohibited. 2 d (ears) 14 d (forage) 48 d (fodder)
Corn, field and pop[c]	2.0 lb / acre	14 days	4	24 hours (21 days for detasseling)	Hand harvest prohibited. 14 d (forage & silage) 48 d (grain & fodder)
Prickly-pear cactus (control of European earwigs)	2.0 lb / acre	7 days	3	12 hours	3 days
Pistachio (non-bearing trees only)	2.0 lb / acre	7 days	yearly max 10 lbs AI / a	12 hours	1 year[d]
Pasture and grasses grown for hay or seed	1.5 lb / acre	14 days	2	12 hours	7 days
Rangeland, ground application	1.0 lb / acre	Limit 1 application / year		12 hours	**?**
Rangeland, as part of the USDA APHIS Program for Mormon Cricket and Rangeland Grasshopper Suppression program (ground or air)	0.2 lb / acre	14 days	2	12 hours	14 days
Ornamental plants around the outside perimeters of buildings (**non-ag "institutional" use)**	0.1 lb / 1000 ft^2	7 days	4	12 hours	N/A

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Appendix 4 (cont.). Application limits, REIs, and PHIs for carbaryl products

Type of Product and Use[a]	Max. rate per application (lbs carbaryl AI per unit area)	Min. retreatment interval	Max. no. of applications per season	REI (re-entry interval)	PHI (before harvesting or grazing)
Carbaryl products labeled for agricultural use (cont.)					
Liquid concentrates (5 products)					
Asparagus, preharvest	1.0 lbs / acre	3 days	3 preharvest	12 hours	1 day
Asparagus, postharvest	2.0 lbs / acre	7 days	5 pre- and post-harvest combined	12 hours	N/A
Brassica vegetables, head and stem (Sub-Group 5 A)	2.0 lbs / acre	7 days	4, and yearly max. 6 lbs AI / a	12 hours	3 days, and only within 30 days of crop emerg.
Brassica vegetables, leafy greens (Sub-Group 5 B)	2.0 lbs / acre	7 days	5, and yearly max. 6 lbs AI / a	12 hours	14 days, and only within 30 days of crop emerg.
Turnip greens	2.0 lbs / acre	7 days	5, and yearly max. 6 lbs AI / a	12 hours	14 days, and only within 30 days of crop emerg.
Cucurbit vegetables (Group 9)	1.0 lbs / acre	7 days	6	12 hours	3 days
Fruiting vegetables, Group 8, *except okra*[e]	2 lbs / acre	7 days	7, and yearly max. 8 lbs AI / a	12 hours	3 days
Okra[e]	1.5 lbs / acre	6 days	4, and yearly max. 6 lbs AI / a	12 hours	3 days
Leaf petiole vegetables (Sub-Group 4B), including chard	2 lbs. / acre	7 days	5, and yearly max. 6 lbs AI / a	12 hours	14 days
Dandelion	2 lbs. / acre	7 days	5, and yearly max. 6 lbs AI / a	12 hours	14 days
Endive (escarole)	2 lbs. / acre	7 days	5, and yearly max. 6 lbs AI / a	12 hours	14 days
Lettuce	2 lbs. / acre	7 days	5, and yearly max. 6 lbs AI / a	12 hours	14 days
Parsley	2 lbs. / acre	7 days	5, and yearly max. 6 lbs AI / a	12 hours	14 days
Spinach	2 lbs. / acre	7 days	5, and yearly max. 6 lbs AI / a	12 hours	14 days

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Appendix 4 (cont.). Application limits, REIs, and PHIs for carbaryl products

Type of Product and Use[a]	Max. rate per application (lbs carbaryl AI per unit area)	Min. retreatment interval	Max. no. of applications per season	REI (re-entry interval)	PHI (before harvesting or grazing)
Carbaryl products labeled for agricultural use (cont.)					
Liquid concentrates (cont.)					
Legume vegetables (including soybean and Sub-Groups 6A, 6C, and 7), *other than* lentils. Use *prohibited* on Sub-Group 6B (fresh/succulent shelled beans and peas) such as garden pea	1.5 lbs / acre	7 days	4	12 hours	3 d (fresh edible-podded); 14 d (forage); 21 d (dried seed or hay)
Root and tuber vegetables, Group 1 (except sugar beets and sweet potatoes)	2 lbs / acre	7 days	6	12 hours	7 days
Sugar beets	1.5 lbs /acre	14 days	2	12 hours	28 days
Sweet potatoes	2 lbs / acre	7 days	8	12 hours	7 days
Sweet corn[c]	2.0 lb / acre	3 days	8	24 hours (21 days for detassel-ing)	Hand harvest prohibited. 2 d (ears) 14 d (forage) 48 d (fodder)
Corn, field and pop[c]	2.0 lbs / acre	14 days	4	24 hours (21 days for detassel-ing)	Hand harvest prohibited. 14 d (forage & silage) 48 d (grain & fodder)
Grain sorghum	2.0 lbs / acre	7 days	4, and yearly max. 6 lbs AI / a	12 hours	14 d (forage & silage) 21 d (grain & fodder)
Rice	1.5 lbs / acre	7 days	2	12 hours	14 days
Forage crops: alfalfa, clover, birdsfoot trefoil	1.5 lb / acre	Do not apply more than once per cutting per year		12 hours	7 days
Prickly-pear cactus (control of European earwigs)	2 lbs / acre	7 days	yearly max. 6 lbs AI / a	12 hours	3 days
Pasture and grasses grown for hay or seed	1.5 lbs / acre	14 days	2	12 hours	14 days
Rangeland, ground application	1.0 lb / acre	limit 1 application per year		12 hours	the day of treatment
Rangeland, as part of the USDA APHIS Program for Mormon Cricket and Grasshopper Suppression (ground or air)	Follow "Reduced Area and Agent Treatment (RAAT)" as detailed on website of USDA ARS research lab in Sidney, Montana: http://www.sidney.ars.usda.gov/grasshopper/Research/lockwood.htm				
Non-cropland [which DPR classifies within "non-production ag"]	1.0 lb / acre	14 days	2, and yearly max. 3 lbs AI /a	12 hours	N/A

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Appendix 4 (cont.). Application limits, REIs, and PHIs for carbaryl products

Type of Product and Use[a]	Max. rate per application (lbs carbaryl AI per unit area)	Min. retreatment interval	Max. no. of applications per season	REI (re-entry interval)	PHI (before harvesting or grazing)
Carbaryl products labeled for agricultural use (cont.)					
Liquid concentrates (cont.)					
Peanuts	2.0 lbs / acre	7 days	5, and yearly max. 8 lbs AI /a	12 hours	14 days
Caneberrys (Subgroup 13-07A) and bushberrys (Subgrp. 13-07B)	2.0 lbs / acre	7 days	5	12 hours	7 days
Cranberry	2.0 lbs / acre	7 days	5	12 hours	7 days
Strawberry	2.0 lbs / acre	7 days	5	12 hours	7 days
Grape	2.0 lbs / acre	7 days	5	6 days	7 days
Sunflowers	1.5 lbs / acre	7 days	2	12 hours	30 d grazing, 60 d harvest for seed
Tobacco	2.0 lbs. / acre	7 days	4	2 days	2 days
Citrus fruits	12.0 lbs / acre[g]	14 days	Scales: 1 only Other pests: 8, and yearly max. 20 lbs AI / a	12 hours if < 5 lbs AI/a; 3 days if 5 or more lbs AI / acre	5 days
Olives	7.5 lbs / acre	14 days	2	3 days	14 days
Pome fruits (Group 11) including apple, pear, and Asian pear *except* do not apply to quince	3.0 lbs / acre	14 days	8, and yearly max. 15 lbs AI / a	12 hours	3 days
Stone fruits (Group 12)	5.0 lbs / acre dormant, 4.0 lbs / acre production	7 days	3, and yearly max. 14 lbs AI / a (5 lbs dormant, 9 lbs production)	12 hours	1 day
Pistachio (including bearing trees)[d]	5.0 lbs / acre[h]	7 days	4, and yearly max. 15 lbs AI / a	12 hours	14 days
Tree nuts (Group 14), including almond and walnut	5.0 lbs / acre	7 days	4, and yearly max. 15 lbs AI / a	12 hours	14 days
Forested areas and rangeland trees (including tree plantations), *except* sugar maples where sap is harvested	1.0 lb / acre	7 days	2	once sprays have dried	**?**
Ornamental plants (either for production or as landscaping)	1.0 lb / acre	7 days for foliar; 6 months for trunk	Foliar: 6 Trunk: 2	12 hours, or 18 days[i]	same as REI ?

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Appendix 4 (cont.). Application limits, REIs, and PHIs for carbaryl products

Type of Product and Use[a]	Max. rate per application (lbs **product** per unit area)	Min. retreatment interval	Max. no. of applications per season	REI (re-entry interval)	PHI (before harvesting or grazing)
Carbaryl products labeled for agricultural use (cont.)					
Liquid concentrates (cont.)					
Turfgrass (either for sod production or as landscaping)	8.0 lbs AI / acre[j] (0.2 lbs AI / 1000 ft^2)[j]	7 days	4, and yearly max. 16 lbs AI / a	24 hours for sod production; Once sprays have dried if not sod production	same as REI ?
Nuisance pests, in band around outside perimeter of structure	2.5 fluid oz product / gal	7 days	4	once sprays have dried	N/A
Carbaryl products labeled for uses *other than* agriculture					
Baits / granules 5% AI (9 products)					
Asparagus, pre-harvest (spears)	0.75 or 1.0 or 4.0 lb product per 1750 ft^2	3 days	3	12 h or until dust has settled[l]	1 day
Asparagus, post-harvest (ferns)	1.0 or 4.0 lb product per 1750 ft^2	3 days or 7 days	5 (pre- and post-harvest combined)	12 h or until dust has settled[l]	1 day
Cucumbers	0.75 or 0.83 or 2.1 lb product per 1750 ft^2	7 days	6	12 h or until dust has settled[l]	1 day
Melons	0.83 or 1.0 or 2.1 lb product / 1750 ft^2	7 days	6	12 h or until dust has settled[l]	1 day
Squash	0.83 or 1.0 or 2.1 lb product / 1750 ft^2	7 days	6	12 h or until dust has settled[l]	1 day
Blueberries and caneberries	1.0 lb / 1750 ft^2 or 1 tsp/7 linear ft	7 days or 14 days	4 or 3	until dust has settled[l]	7 days
Carrots	1.0 or 4.0 lb product / 1750 ft^2	7 days	4 or 6	until dust has settled[l]	7 days
Potatoes	1.0 or 1.7 or 4.0 lb product / 1750 ft^2	7 days	4 or 3	until dust has settled[l]	7 days
Radishes	1.0 or 4.0 lb product / 1750 ft^2	7 days	3 or 4 or 6	until dust has settled[l]	7 days
Turnips (roots)	1.0 or 4.0 lb product / 1750 ft^2	7 days	3 or 4 or 6	until dust has settled[l]	7 days
Turnip tops	2.3 lbs product / 1000 ft^2	7 days	3	watering-in has dried[l]	14 days
Broccoli	1.0 or 4.0 lb product / 1750 ft^2	7 days or 14 days	4 or 3	until dust has settled[l]	3 days or 15 days
Brussels sprouts	1.0 or 4.0 lb product / 1750 ft^2	7 days or 14 days	4 or 3	until dust has settled[l]	3 days or 15 days

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Appendix 4 (cont.). Application limits, REIs, and PHIs for carbaryl products

Type of Product and Use[a]	Max. rate per application (lbs **product** per unit area)	Min. retreatment interval	Max. no. of applications per season	REI (re-entry interval)	PHI (before harvesting or grazing)
Carbaryl products labeled for uses *other than* agriculture (cont.)					
Baits / granules 5% AI (cont.)					
Cabbage	1.0 or 4.0 lb product / 1750 ft^2	7 days or 14 days	4 or 3	until dust has settled[l]	3 days or 15 days
Chinese cabbage	2.3 lbs product / 1000 ft^2	7 days	4	watering-in has dried[l]	14 days
Cauliflower	1.0 or 4.0 lb product / 1750 ft^2	7 days or 14 days	4 or 3	until dust has settled[l]	3 days or 15 days
Cavalo broccolo[k]	1.0 or 4.0 lb product / 1750 ft^2	7 days or 14 days	4 or 3	until dust has settled[l]	3 days or 15 days
Kohlrabi	1.0 or 4.0 lb product / 1750 ft^2	7 days or 14 days	4 or 3	until dust has settled[l]	3 days or 15 days
Collards	1.0 or 4.0 lb product / 1750 ft^2	7 days or 14 days	4 or 3	until dust has settled[l]	14 days or 15 days
Kale	1.0 or 4.0 lb product / 1750 ft^2	7 days or 14 days	4 or 3	until dust has settled[l]	14 days or 15 days
Mizuna	1.0 or 4.0 lb product / 1750 ft^2	7 days or 14 days	4 or 3	until dust has settled[l]	14 days or 15 days
Mustard greens	0.7 or 1.0 or 4.0 lb product / 1750 ft^2	7 days or 14 days	4 or 3	until dust has settled[l]	14 days or 15 days
Rape greens	1.0 lb / 1750 ft^2 or 1 tsp/7 linear ft	7 days or 14 days	4 or 3	until dust has settled[l]	14 days or 15 days
Lettuce	1 tsp / 12 ft^2	14 days	3	until dust has settled[l]	14 days
Spinach	1 tsp / 12 ft^2	14 days	3	until dust has settled[l]	14 days
Tomatoes	1.0 or 4.0 lb product / 1750 ft^2	7 days or 14 days	4 or 3	until dust has settled[l]	3 days
Eggplant	1.0 or 4.0 lb product / 1750 ft^2	7 days or 14 days	4 or 3	until dust has settled[l]	3 days
Pepper	1.0 or 4.0 lb product / 1750 ft^2	7 days or 14 days	4 or 3	until dust has settled[l]	3 days
Strawberry	1 tsp/ 7 linear ft; or 1.0 or 2.3 lbs product / 1,000 ft^2	14 days or 7 days	3 or 5	until product not visible[l]	7 days
Edible-podded legume vegetables (snap bean, etc.). "Use on succulent peas or beans is prohibited."[n]	0.64 or 1.7 lb product / 1000 ft^2	7 days	4	12 hours or watering-in has dried[l]	3 days pods 14 d forage 21 d hay
Dried shelled peas and beans, including lentils	0.64 or 1.7 lb product / 1000 ft^2	7 days	4	12 hours or watering-in has dried[l]	21 days
Garden beets (roots)	0.6 or 2.3 lb product / 1000 ft^2	7 days	3 or 6	watering-in has dried[l]	7 days
Beet tops	2.3 lbs product / 1000 ft^2	7 days	3	watering-in has dried[l]	14 days

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Appendix 4 (cont.). Application limits, REIs, and PHIs for carbaryl products

Type of Product and Use[a]	Max. rate per application (lbs **product** per unit area)	Min. retreatment interval	Max. no. of applications per season	REI (re-entry interval)	PHI (before harvesting or grazing)
Carbaryl products labeled for uses *other than* agriculture (cont.)					
Baits / granules 5% AI (cont.)					
Horseradish	0.6 or 2.3 lb product / 1000 ft^2	7 days	3 or 6	watering-in has dried[l]	7 days
Parsnips	0.6 or 2.3 lb product / 1000 ft^2	7 days	3 or 6	watering-in has dried[l]	7 days
Rutabaga	0.6 or 2.3 lb product / 1000 ft^2	7 days	3 or 6	watering-in has dried[l]	7 days
Salsify	0.6 or 2.3 lb product / 1000 ft^2	7 days	3 or 6	watering-in has dried[l]	7 days
Corn, sweet	0.6 lb product / 1000 ft^2	3 days	8	12 hours Hand-detasseling prohibited	2 d ears 14 d forage 48 d fodder
Flowers, ornamentals, and non-turf ground cover	1.0 or 3.5 lb product / 1750 ft^2	7 days or 21 days	3 or 6	until dust has settled[l]	N/A
Lawns (*not* for use on sod farms)	2.4 or 4.0 or 9.0 lb product / 1000 ft^2	7 days	4	12 hours or watering-in has dried[l]	N/A
Nuisance pests around the outside of homes, porches, and patios	2.4 or 9.0 lb product / 1000 ft^2	7 days	4	watering-in has dried[l]	N/A
Liquid concentrates 22. 5% AI (2 products)					
Asparagus	Dilute to 0.3% - 0.5% AI, spray until covered	N/A	3	Until sprays have dried	1 day
Brassica head and stem vegetables	Dilute to 0.3% - 0.5% AI, spray until covered	N/A	4	Until sprays have dried	3 days
Brassica leafy green vegetables	Dilute to 0.3% - 0.5% AI, spray until covered	N/A	4	Until sprays have dried	14 days, and only within 30 days of crop emerg.
Corn (sweet)	Dilute to 0.3% - 0.5% AI, spray until covered	N/A	8	Until sprays have dried	2 days
Cucurbit vegetables	Dilute to 0.3% - 0.5% AI, spray until covered	N/A	6	Until sprays have dried	3 days
Dried shelled legume vegetables, including lentils	Dilute to 0.3% - 0.5% AI, spray until covered	N/A	4	Until sprays have dried	21 days

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Appendix 4 (cont.). Application limits, REIs, and PHIs for carbaryl products

Type of Product and Use[a]	Max. rate per application (lbs **product** per unit area)	Min. retreatment interval	Max. no. of applications per season	REI (re-entry interval)	PHI (before harvesting or grazing)
Carbaryl products labeled for uses *other than* agriculture (cont.)					
Liquid concentrates 22. 5% AI (cont.)					
Edible-podded legume vegetables (such as snow pea); but use *prohibited* on "fresh/succulent peas and beans"[n]	Dilute to 0.3% - 0.5% AI, spray until covered	N/A	4	Until sprays have dried	3 days
Fruiting vegetables (such as tomato)	Dilute to 0.3% - 0.5% AI, spray until covered	N/A	7	Until sprays have dried	3 days
Leafy vegetables, including lettuce and celery and chard	Dilute to 0.3% - 0.5% AI, spray until covered	N/A	5	Until sprays have dried	14 days
Root and tuber vegetables, *except* sweet potatoes or sugar beet	Dilute to 0.3% - 0.5% AI, spray until covered	N/A	6	Until sprays have dried	7 days
Sweet potatoes	Dilute to 0.3% - 0.5% AI, spray until covered	N/A	8	Until sprays have dried	7 days
Tree fruits (including apples and peaches)	Dilute to 0.3% - 0.5% AI, spray to runoff	7 days	8	Until sprays have dried	3 days
Citrus fruits	Dilute to 0.3% - 0.5% AI, spray to runoff	7 days	8	Until sprays have dried	5 days
Small fruits including caneberries, strawberries, and grapes	Dilute to 0.3% - 0.5% AI, spray to runoff	7 days	5	Until sprays have dried	7 days
Ornamental trees, shrubs, and flowers (use on lawns *prohibited*)	Dilute to 0.3% - 0.5% AI, spray to runoff. On trees, limit to spot treatments.	7 days	4 for trees, 6 for shrubs / flowers	Until sprays have dried	N/A
"Nuisance pests around outdoor residential areas" (perimeter treatment) - - use on lawns *prohibited*	Dilute to 0.5% AI, thoroughly spray outside perimeter of the home	N/A	N/A	Until sprays have dried	N/A

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Appendix 4 (cont.). Application limits, REIs, and PHIs for carbaryl products

Type of Product and Use[a]	Max. rate per application (lbs **product** per unit area)	Min. retreatment interval	Max. no. of applications per season	REI (re-entry interval)	PHI (before harvesting or grazing)
Carbaryl products labeled for uses *other than* agriculture (cont.)					
Liquid ready-to-use 0.126% AI (2 products)					
Asparagus	Effectively cover upper and lower surfaces of plant	7 days	3	Until sprays have dried	1 day
Brassica head and stem vegetables	Effectively cover upper and lower surfaces of plant	7 days	4	Until sprays have dried	3 days
Brassica leafy green vegetables	Effectively cover upper and lower surfaces of plant	7 days	4	Until sprays have dried	14 days, and only within 30 days of crop emerg.
Corn (sweet)	Effectively cover upper and lower surfaces of plant	7 days	8	Until sprays have dried	2 days
Cucurbit vegetables	Effectively cover upper and lower surfaces of plant	7 days	6	Until sprays have dried	3 days
Dried shelled legume vegetables, including lentils	Effectively cover upper and lower surfaces of plant	7 days	4	Until sprays have dried	21 days
Edible-podded legume vegetables (such as snow pea); but use *prohibited* on "fresh/succulent peas and beans"[n]	Effectively cover upper and lower surfaces of plant	7 days	4	Until sprays have dried	3 days
Fruiting vegetables (such as tomato), *except* okra	Effectively cover upper and lower surfaces of plant	7 days	7	Until sprays have dried	3 days
Okra	Effectively cover upper and lower surfaces of plant	7 days	4	Until sprays have dried	3 days
Leafy vegetables, including lettuce and celery and chard	Effectively cover upper and lower surfaces of plant	7 days	5	Until sprays have dried	14 days
Root and tuber vegetables, *except* sweet potatoes or sugar beet	Effectively cover upper and lower surfaces of plant	7 days	6	Until sprays have dried	7 days
Sweet potatoes	Effectively cover upper and lower surfaces of plant	7 days	8	Until sprays have dried	7 days
Peanuts	Effectively cover upper and lower surfaces of plant	7 days	5	Until sprays have dried	14 days
Tree fruits (including apples and peaches)	upper and lower surfaces, spray to the point of runoff	7 days	8	Until sprays have dried	3 days

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Appendix 4 (cont.). Application limits, REIs, and PHIs for carbaryl products

Type of Product and Use[a]	Max. rate per application (lbs **product** per unit area)	Min. retreatment interval	Max. no. of applications per season	REI (re-entry interval)	PHI (before harvesting or grazing)
Carbaryl products labeled for uses *other than* agriculture (cont.)					
Liquid ready-to-use 0.126% AI (cont.)					
Small fruits including caneberries, strawberries, grapes	upper and lower surfaces, spray to the point of runoff	7 days	5	Until sprays have dried	7 days
Ornamental trees, shrubs, and flowers	upper and lower surfaces, spray to the point of runoff	7 days	4 for trees, 6 for shrubs / flowers	Until sprays have dried	N/A
"Nuisance pests around outdoor residential areas" (perimeter treatment) - - use on lawns *prohibited*	Thoroughly wet the outside perimeter of dwellings	7 days	N/A	Until sprays have dried	N/A
Dust ready-to-use 5% AI (1 product)					
Edible-podded legume vegetables (such as snow pea); but use *prohibited* on "fresh/succulent peas and beans"[n]	Dust lightly to cover leaf surfaces with a thin, even film of dust	7 days	4	Until dusts have settled	3 days
Dried shelled legume vegetables *except* lentils	Dust lightly to cover leaf surfaces with a thin, even film of dust	7 days	4	Until dusts have settled	21 days
Broccoli, Brussels sprouts, cabbage, cauliflower, kohlrabi	Dust lightly to cover leaf surfaces with a thin, even film of dust	7 days	4	Until dusts have settled	3 days, and apply only within 30 days of crop emerg.
Collards, garden beets, kale, lettuce, mustard greens, radishes, rutabagas, spinach, turnips	Dust lightly to cover leaf surfaces with a thin, even film of dust	7 days	4	Until dusts have settled	7 d roots (radish, rutabaga, turnip); 14 d tops; apply only within 30 days of crop emerg.
Cantaloupe, cucumbers, melons, pumpkins, squash	Dust lightly to cover leaf surfaces with a thin, even film of dust	7 days	6	Until dusts have settled	3 days
Carrots	Dust lightly to cover leaf surfaces with a thin, even film of dust	7 days	6	Until dusts have settled	7 days

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Appendix 4 (cont.). Application limits, REIs, and PHIs for carbaryl products

Type of Product and Use[a]	Max. rate per application (lbs **product** per unit area)	Min. retreatment interval	Max. no. of applications per season	REI (re-entry interval)	PHI (before harvesting or grazing)
Carbaryl products labeled for uses *other than* agriculture (cont.)					
Dust ready-to-use 5% AI (cont.)					
Eggplant, peppers, tomato	Dust lightly to cover leaf surfaces with a thin, even film of dust	7 days	7	Until dusts have settled	3 days
Potato	Dust lightly to cover leaf surfaces with a thin, even film of dust	7 days	6	Until dusts have settled	7 days
Small fruits, including caneberries, blueberries, strawberries, and grapes	Dust lightly to cover leaf surfaces with a thin, even film of dust	7 days	5	Until dusts have settled	7 days
Ornamental shrubs and flowers	Dust lightly to cover leaf surfaces with a thin, even film of dust.	7 days	6	Until dusts have settled	N/A
Home lawns	Sprinkle lightly on grass	14 days	4	Until dusts have settled[m]	N/A
Control of nuisance earwigs (to reduce the number gaining entrance to homes)	Lightly dust a band 3 – 4 in wide around the outside foundation wall of the home. Also apply around areas in the yard offering concealment (refuse piles, lumber, mulch, etc.)	10 days or when earwigs become troublesome	N/A	Until dusts have settled[m]	N/A

Notes:

a "Group" refers to crop groups used by U.S. EPA when setting pesticide residue tolerances (40 CFR 180.41 available at http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=bd6912f4c712173a8c06493f0b26ec1b&tpl=/ecfrbrowse/Title40/40cfr180_main_02.tpl)

b One bait product (Anderson's) is dual-use: it is labeled for both ag and home use.

c Regarding corn, some (but not all) bait labels say, "Use prohibited in CA".

d For pistachio, bait use is allowed only on non-bearing trees: "Use only on trees that will not bear fruit for one year from the date of application." In contrast, liquid concentrate labels do not include this restriction.

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Appendix 4 (cont.). Application limits, REIs, and PHIs for carbaryl products

e Okra is listed separately even though it is a member of Crop Group 8-10, Fruiting Vegetables. On all labels, okra restrictions are slightly different from those of other Fruiting Vegetables. In addition, some (but not all) liquid concentrate labels say for okra, "Use not permitted in CA."

f "Regulatory Pest Control" is a pesticide use category defined on DPR's Monthly Summary Pesticide Use Report form. I have requested a determination by DPR's Enforcement Branch about whether the category is classified within ag-use, or non-ag use. In the absence of a government-mandated pest control program, DPR classifies this use site, rangeland, as production agriculture.

g For citrus, labels allow the rate of 12 lbs AI / a only for red and yellow scale insects. For all other pests, labels recommend a maximum rate of 5 lbs AI / a.

h For pistachio, some liquid-concentrate labels allow up to 6 lbs AI / a for a single application per year. Additional applications must not exceed 5 lbs AI / a.

i For ornamental plants, REI for liquid concentrates is 18 days only for, "ornamentals grown for cuttings (cut flowers or cut foliage) where production is in outdoor areas and where average annual rainfall is less than 25 inches a year."

j Broadcast applications to turfgrass are allowed only on golf courses, sod farms, cemeteries, and commercial landscapes. Applications to all other lawns and turf (residential settings) are limited to spot treatments.

k "Cavala broccolo," also known as smooth-leaved broccoli, elsewhere is usually spelled "cavolo broccolo,"

l REI for home-use baits: some, but not all, labels add the statement, "Do not allow people (except those involved in the watering-in) to enter the treated area until the watering-in is completed and the area has dried." Other labels state, "Children and domestic animals must be kept out of treated areas from the start of application until the applied product is no longer visible." The dual-use product (Anderson's) has ag-use REI of 12 hours.

m Ready-to-use dust for lawn and perimeter applications: even after dusts have settled, a layer of dust is intended to remain on the surface of lawn or ground. Lawn instructions state, "For best results, apply after rain or watering and do not water for at least 2 days after application." Perimeter instructions state, "If the dust barrier is washed away by rain, it should be replaced with a new application if earwigs are still a problem."

n In use instructions for legume vegetables, most home-use products state, "Use on succulent peas or beans is prohibited" despite being labeled for use on edible-podded varieties (such as snow pea) that typically are harvested and eaten while succulent (green and tender). The wording of the home-use prohibition makes it difficult to understand (Vic Acosta, personal communication, 17 March 2015). It seems likely that the registrants' intent was to prohibit use on legume vegetables in Sub-Group 6B, named "Succulent shelled pea and bean subgroup". Labels of ag-use liquid concentrates include an explicit prohibition against use on Sub-Group 6B. Further, U.S. EPA has not established a tolerance for carbaryl residues on Sub-Group 6B, but has established tolerances on Sub-Groups 6A and 6C (40 CFR 180.169).

Appendix 5. How risk estimates were calculated within the RCD (Rubin 2004)

The RCD (Rubin 2014) presents six tables of risk calculations for a range of exposure scenarios, tabulating Margins of Exposure (MOE's) for non-oncogenic risks and also tabulating values of oncogenic risk. Four of those six tables are explained in this Appendix. In contrast, RCD tables IV-9 (toddler scenarios) and IV-10 (surface-water swimmer scenarios) are not discussed here because all MOE's greatly exceeded 100 (Rubin 2014, p. 145). For the four tables that are explained, the explanations in this Appendix start with the calculation of risk (such as MOE), and proceed "backwards" to calculations of absorbed dose and then to the sources of exposure-rate estimates.

Contents of Appendix 5:

1. Occupational Handler scenarios (risk calculations in RCD Table IV-7a)

1.1 Calculations of risk (MOE's and oncogenic risk) for handlers

Table format: The first few rows of RCD Table IV-7a are reproduced below. Column labels (such as "A" and "B") have been added to help explain the calculations:

Table IV-7a. Occupational handler risks from carbaryl exposure by the dermal and inhalation routes – short-term, seasonal, annual and lifetime exposure scenarios

	Short-term MOE			Seasonal MOE			Annual MOE			Oncogenic risk		
Exposure scenario	Dermal **"A"**	Inhalation **"B"**	Aggregate **"C"**	Dermal **"D"**	Inhalation **"E"**	Aggregate **"F"**	Dermal **"G"**	Inhalation **"H"**	Aggregate **"I"**	Dermal **"J"**	Inhalation **"K"**	Aggregate **"L"**
Handlers: aerial applications												
Aerial (liquids)												
Mixer / loader	0.23	23	0.23 (0.23)	11	552	11	45	2212	44 (43)	$1.62x10^{-3}$	$1.18x10^{-6}$	$1.62x10^{-3}$ ($1.62x10^{-3}$)
Applicator	29	182	25 (23)	1308	4425	1010	5224	17,730	4035 (1325)	1.39×10^{-5}	1.46×10^{-7}	1.40×10^{-5} (1.77×10^{-5})
High-acre aerial (liquid)												
Mixer / loader	0.54	53	0.53 (1)									
Applicator	63	424	55 (44)									

"A" Short-term dermal MOE

MOE = NOEL / exposure dose (Rubin 2014, page 134). An example of "exposure dose" is Short-Term Absorbed Daily Dosage (STADD).

NOEL for acute dermal exposure = **14 mg / kg** (Rubin 2014, page 138, footnote "a")

Exposure dose estimates for short-term handler exposure are taken from Table IV-2a in the RCD (Rubin 2014), which simply copies the estimates of absorbed dose that are presented in the Exposure Assessment (Beauvais 2014). Calculation of exposure doses is explained in section 1.2 of this Appendix.

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Sample risk calculation, short-term dermal MOE for Aerial (liquids) Mixer / loader:

MOE = NOEL / exposure dose = (14 mg/kg) / (STADD from Table IV-2a) = (14 mg/kg) / (60.8 mg/kg/day) = **0.23**

"B" Short-term inhalation MOE

MOE = NOEL / exposure estimate (Rubin 2014, page 134)

NOEL for acute inhalation exposure = **1 mg / kg** (Rubin 2014, page 138, footnote "b" and text on page 114)

Exposure dose estimates for short-term handler exposure are taken from Table IV-2a in the RCD (Rubin 2014), which simply copies the estimates of absorbed dose that are presented in the Exposure Assessment (Beauvais 2014). Calculation of exposure doses is explained in section 1.2 of this Appendix.

Sample risk calculation, short-term inhalation MOE for Aerial (liquids) Mixer / loader:

MOE = NOEL / exposure = (1 mg/kg) / (STADD from Table IV-2a) = (1 mg/kg) / (0.0440 mg/kg/day) = **23**

"C" Short-term aggregate MOE's

Aggregate MOE's <u>not</u> in parentheses:

MOE = the aggregate, multi-route non-oncogenic risk is calculated via the "hazard index," which is the reciprocal of the sum of the reciprocals of the dermal and inhalation MOE values (Rubin 2014, page 138, footnote "c"). In other words, for aggregate MOE's within Table IV-7a that are <u>not</u> enclosed in parenthese:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{"A"}) + (1 / \text{"B"})}$$

Sample risk calculation, aggregate MOE <u>not</u> including dietary risk for Aerial (liquids) Mixer / loader:

$$\text{Aggregate MOE} = \frac{1}{(1/\text{“A”}) + (1/\text{“B”})} = \frac{1}{(1/0.23) + (1/23)} = \mathbf{0.23}$$

Aggregate MOE's enclosed within parentheses:

MOE: For aggregate MOE's that are enclosed in parentheses, the dietary MOE is also included in the denominator of the hazard index. Within Table IV-7a, "Values in parentheses represent the aggregate acute or chronic risk for dermal, inhalation and dietary exposure. The aggregate acute MOE assumed a Monte Carlo-derived, 99.9% percentile **dietary acute MOE of 228** for working adults (DPR, 2010), based on the acute oral NOEL of 1 mg/kg" (Rubin 2014, page 138, footnote "c").

In other words, for values within parentheses:

$$\text{Aggregate MOE} = \frac{1}{(1/\text{“A”}) + (1/\text{“B”}) + (1/\text{dietary MOE})}$$

Sample calculation, aggregate MOE including dietary risk for Aerial (liquids) Mixer / loader:

$$\text{Aggregate MOE} = \frac{1}{(1/\text{“A”}) + (1/\text{“B”}) + (1/\text{dietary MOE})}$$

$$= \frac{1}{(1/0.23) + (1/23) + (1/228)} = \mathbf{0.23}$$ (versus 0.20 in Table IV-7a; perhaps a rounding error? Other rows of table match exactly.)

"D," "E," "F," "G," "H," and "I": Seasonal and Annual MOE's

For most handler scenarios, seasonal and annual sources of exposure estimates and calculations of MOE's are the same as for the short-term MOE's (which were shown above). Therefore, seasonal and annual calculations are not presented here. Values for the relevant NOELs are as follows:

Seasonal dermal NOEL: **14 mg / kg** (Rubin 2014, page 138, footnote "a" and page 117 text)

Seasonal inhalation NOEL: **0.05 mg / kg** (Rubin 2014, page 138, footnote "b" and page 117 text)

Annual dermal NOEL: **14 mg / kg** (Rubin 2014, page 138, footnote "a" and page 117 text)

Annual inhalation NOEL: **0.05 mg / kg** (Rubin 2014, page 138, footnote "b" and page 117 text)

In contrast, for some rows of Table IV-7a, such as "High Area Aerial (Liquid)," the columns for Seasonal and Annual are lined out (in other words, no values are given for Seasonal or Annual). The reason is,"SADDs, AADDs and LADDs were not calculated for high-acre liquid and granular applications. According to DPR (2011), only short-term estimates were needed for these scenarios" (Rubin 2014, page 126, "Note").

"J," "K," and "L" : Oncogenic risks

Oncogenic risk = (human oncogenic potency) x (lifetime average daily dose) (Rubin 2014, page 139, footnote "d")

Because oncogenic risk is expressed as a risk, rather than as a safety margin MOE, oncogenic risk becomes unacceptable as values grow larger (indicating more risk). "Risk values less than 10^{-6} (i.e., <1 excess cancer per one million individuals) are considered negligible" (Rubin 2014, page 134).

Human oncogenic potency = 9.72 x 10^{-3} mg/kg/day^{-1} (Rubin 2014, page 139, footnote "d"; and page 120). This is also referred to as the Multistage Cancer Slope Factor. As summarized in Rubin 2014 (pages 120-121), the potency value was calculated by Beauvais (2014) based on several mouse oncogenicity trials, especially Hamada (1993b) and a U.S. EPA-sponsored reanalysis of the pathology slides (U.S.EPA 2002b).

Lifetime average daily dose (LADD) values for handlers are taken from Table IV-2a in the RCD (Rubin 2014), which simply copies the LADD estimates that are presented in the Exposure Assessment (Beauvais 2014). Calculation of LADD is explained in section 1.2 of this Appendix.

Sample calculation: dermal oncogenic risk for Aerial (liquids) Mixer / loader:

Oncogenic risk = (human oncogenic potency) x (dermal LADD from Table IV-2a)

= $(9.72 \times 10^{-3}$ mg/kg/day$^{-1})$ x (0.167 mg/kg/day)

= **1.62×10^{-3} excess cancer cases**

Similarly, inhalation and aggregate oncogenic risks are calculated from inhalation LADD and total LADD, respectively.

1.2 Calculations of absorbed exposure dose (STADD, LADD, etc.) for handlers

Table format: The first few rows of RCD Table IV-2a are reproduced below. Column labels (such as "M" and "N") have been added to help explain the calculations:

Table IV-2a. Occupational handler exposure to carbaryl by the dermal and inhalation routes - short-term, seasonal, annual and lifetime estimates

	STADD (mg/kg/day)			SADD (mg/kg/day)			AADD (mg/kg/day)			LADD (mg/kg/day)		
Exposure scenario	Dermal **"M"**	Inhalation **"N"**	Total **"O"**	Dermal **"P"**	Inhalation **"Q"**	Total **"R"**	Dermal **"S"**	Inhalation **"T"**	Total **"U"**	Dermal **"V"**	Inhalation **"W"**	Total **"X"**
Handlers: aerial applications												
Aerial (liquids)												
Mixer / loader	60.8	0.0440	60.8	1.25	0.000905	1.25	0.313	0.000226	0.313	0.167	0.000121	0.167
Applicator	0.521	0.00550	26.0	0.0107	0.000113	0.0108	0.00268	0.0000282	0.00270	0.00143	0.0000150	0.00144
High-acre aerial (liquid)												
Mixer / loader	26.0	0.0189	0.226									
Applicator	0.223	0.00236	0.241									

"M", "N", and "O": Short-Term Absorbed Daily Dosage (STADD) for handlers

As explained by Beauvais (2014) on page 52 footnote "e," **STADD** for handlers is calculated from short-term exposure as follows:

STADD = [(short-term exposure) x (absorption) x (acres treated/day) x (application rate)] / (70 kg body weight)

Sources of exposure estimates for handlers are listed in Table A5-1 later in this Appendix. For the remaining parameters used to calculate STADD for handlers, Beauvais (2014) used the following assumptions (page 52, footnote "e"):

- **Dermal absorption** = 70% (Beauvais, 2006a).
- **Body weight** = 70 kg (Thongsinthusak et al., 1993).
- **Inhalation rate** = 16.7 liters/min (Andrews and Patterson, 2000).
- **Inhalation absorption** = 100% (Frank, 2008).
- **Application rate** = the maximum allowed by any carbaryl labeling for a given scenario (i.e., for a given combination of formulation and application method). For example, for aerial application of liquids, the application rate assumed for STADD was 12 lbs AI / a, which is the maximum label rate for citrus (Beauvais 2014, page 52, footnote "f"). ***Although this is an allowed rate for citrus, it is worth noting that for most crops, carbaryl labeling limits the maximum rate to only 2 lbs AI / a (see Appendix 4).*** Less-conservative rate assumptions were used for seasonal and annual dose calculations.
- **Acres treated / day** = standard value recommended in U.S. EPA (2001) for a given scenario. For example, for aerial application of liquids, workload was assumed to be 350 acres treated / day (Beauvais 2014, page 52, footnote "f").

Sample calculations, mixer/loader for aerial application of liquids (corresponding to the first row of Table 22 in Beauvais 2014):

STADD (dermal) = [(short-term exposure) x (absorption) x (acres treated/day) x (application rate)] / (70 kg body weight)

= [(1446 µg / lb AI handled) x (0.001 mg / µg) x (70%) x (350 acres/day) x (12 lbs AI / acre)] / (70 kg body weight)

= 60.7 mg AI / kg body weight / day

STADD (inhalation) = [(short-term exposure) x (absorption) x (acres treated/day) x (application rate)] / (70 kg body weight)

= [(0.734 µg / lb AI handled) x (0.001 mg / µg) x (100%) x (350 acres/day) x (12 lbs AI / acre)] / (70 kg body weight)

= 0.0440 mg AI / kg body weight / day

STADD (total) = STADD (dermal) + STADD (inhalation) = 60.7 + 0.0440 **= 60.7 mg AI / kg body weight / day**

"P", "Q", and "R": Seasonal Absorbed Daily Dosage (SADD) for handlers

As explained by Beauvais (2014) on page 53 footnote "b," the formula used to calculate **SADD** for handlers is equivalent to the STADD formula, except that it uses long-term handler exposure. Other differences from STADD is that SADD calculations assume:

- **120 acres treated/day**, based on average number of acres treated by each grower daily, as reported in the DPR's Pesticide Use Report; and
- an application rate of **2 lbs AI/acre**, the typical rate reported for aerial applications to tomatoes (Beauvais 2014, page 53, footnote "b").

Sample calculation, mixer / loader for aerial application of liquids (corresponding to the first row of Table 23 in Beauvais 2014):

SADD (dermal) = [(long-term exposure) x (absorption) x (acres treated/day) x (application rate)] / (70 kg body weight)

= [(520.9 µg / lb AI handled) x (0.001 mg / µg) x (70%) x (120 acres/day) x (2 lbs AI / acre)] / (70 kg body weight)

= **1.25 mg AI / kg body weight / day**

SADD (inhalation) is calculated similarly, using inhalation long-term exposure rates, as was shown for STADD.
SADD (total) is simply the sum of SADD (dermal) plus SADD (inhalation), as was shown for STADD.

"S", "T", and "U": Annual Average Daily Dosage (AADD) for handlers

As explained by Beauvais (2014) on page 53 footnote "c," **AADD** for handlers is calculated from SADD as follows:

AADD = SADD x (annual use months per year) / (12 months in a year).

Annual use is based on California's high-use period of 3 months (Beauvais 2014, page 53, footnote "c").
Note that this 3-month estimate is longer than the 1-month estimate that was used to calculate annual dosage for bystanders (Beauvais 2014, page 86, footnote "g").

Sample calculation, mixer / loader for aerial application of liquids (corresponding to the first row of Table 23 in Beauvais 2014):

AADD (dermal) = SADD (dermal) x (annual use months per year) / (12 months in a year).
= (1.25 mg / kg / day) x (3 months of use) / (12 months per year)
= **0.313 mg/kg/day**

AADD (inhalation) is calculated similarly, using SAAD (inhalation) as the input.

AADD (total) is simply the sum of AADD (dermal) plus AADD (inhalation).

"V", "W", and "X": Lifetime Average Daily Dosage (LADD) for handlers

As explained by Beauvais (2014) on page 53 footnote "d," **LADD** for handlers is calculated from AADD as follows:

LADD = AADD x (40 years of work in a lifetime) / (75 years in a lifetime)

Sample calculation**,** mixer / loader for aerial application of liquids (corresponding to the first row of Table 23 in Beauvais 2014):

LADD (dermal) = AADD (dermal) x (40 years of work in a lifetime) / (75 years in a lifetime)
= (0.313 mg/kg/day) x (40 years) / (75 years)
= **0.167 mg/kg/day**

LADD (inhalation) is calculated similarly, using AADD (inhalation) as the input.

LADD (total) is simply the sum of LADD (dermal) plus LADD (inhalation).

1.3 Sources of exposure rates for handlers

For Occupational Handler scenarios, sources of exposure rate estimates are listed in Table A5-1 (below). Because exposure rates for Occupational Handler scenarios are derived from actual exposure monitoring, or from the PHED database, no sample calculation of the exposure rate itself is shown here. For more information about calculation procedures used for PHED, see Beauvais 2014 Appendix 3.

Table A5-1. Occupational Handler scenarios: Sources of the exposure rates used to calculate absorbed exposure doses in RCD Table IV-2a, which in turn were used for risk calculations in RCD Table IV-7a

Exposure scenario (A = applicator, L = loader, M = mixer)	**Source of exposure rates (µg / lb AI handled)**	**Citation to document the source (within Beauvais 2014)**
Dust loader / applicator	calculated by Beauvais (2011), using data from carbaryl exposure monitoring study (Merricks 1997)	Table 20, footnote "d"
Airblast applicator	calculated by Beauvais (2011), using data from carbaryl exposure monitoring study (Smith 2005)	Table 21, footnote "a"
Trigger spray applicator, for ready-to-use liquid	calculated by Beauvais (2011), using data from carbaryl exposure monitoring study (Merricks 1997)	Table 20, footnote "e"
Hand-pump sprayer (a.k.a. low-pressure handwand) M/L/A	calculated by Beauvais (2011), using data from carbaryl exposure monitoring study (Merricks 1997)	Table 20, footnote "e"
Hose-end sprayer loader / applicator	calculated by Beauvais (2011), using data from carbaryl exposure monitoring study (Merricks 1997)	Table 20, footnote "e"
All other Occupational Handler scenarios listed in RCD Table IV-7a	Pesticide Handler Exposure Database (PHED)	p. 50 (text), and footnotes in Tables 22 - 29

2. Occupational Re-entry scenarios (risk calculations in RCD Table IV-7b)

2.1 Calculations of risk (MOE's and oncogenic risk) for occupational re-entry

Table format: The first few rows of RCD Table IV-7b are reproduced below. Column labels (such as "Y" and "Z") have been added to help explain the calculations:

Table IV-7b. MOE's and oncogenic risk values for occupational reentry carbaryl dermal exposure scenarios – short-term, seasonal, annual and lifetime estimates

Exposure scenario	MOE, short-term **"Y"**	MOE, seasonal **"Z"**	MOE, annual **"AA"**	Oncogenic risk **"AB"**
Apple hand thinning	4 (4)	7	27 (27)	2.68×10^{-3} (2.68×10^{-3})
Asparagus hand harvesting	4 (4)			
Beans scouting	19 (18)			

"Y" Short-term MOE's for occupational re-entry

Short-term MOE's not in parentheses:

MOE = NOEL / exposure dose (Rubin 2014, page 134). An example of "exposure dose" is Short-Term Absorbed Daily Dosage (STADD).

NOEL for acute dermal exposure = **14 mg / kg** (Rubin 2014, page 138, footnote "a")

Exposure dose estimates for re-entry exposure are taken from Table IV-2b in the RCD (Rubin 2014), which simply copies the estimates of absorbed dose that are presented in the Exposure Assessment (Beauvais 2014). Calculation of exposure doses is explained in section 2.2 of this Appendix.

Sample risk calculation, short-term dermal MOE for apple hand thinning re-entry:

MOE = NOEL / exposure dose = (14 mg/kg) / (STADD from Table IV-2b) = (14 mg/kg) / (3.41 mg/kg/day) = **4**

Short-term MOE's contained within parentheses:

"Aggregate risk from dermal and dietary exposures appear in parentheses (no combined value appears for seasonal risk because such a value was not calculated for dietary exposure). As with the handler scenarios, the combined acute MOE assumed a Monte Carlo-derived, 99.9% percentile **dietary acute MOE of 228** for working adults (DPR, 2010), which was based on the acute oral NOEL of 1 mg/kg. The aggregate chronic MOE assumed a **chronic dietary MOE of 1973** for adults, 20-49 years old (DPR, 2010), which was based on the chronic oral 140 NOEL of 0.5 mg/kg/day." (Rubin 2014, page 140, "Note").

Although not stated in the Note for Table IV-7b, the tabulated values indicate that aggregate short-term re-entry risk was calculated via the "hazard index," which is the reciprocal of the sum of the reciprocals of the MOE values (Rubin 2014, page 138, footnote "c"). In other words, for the values contained in parentheses:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{"M"}) + (1 / \text{MOE for dietary risk})}$$

Sample risk calculation, combined dermal and dietary acute risk for apple hand thinning re-entry:

$$\text{Aggregate acute MOE} = \frac{1}{(1 / \text{"M"}) + (1 / \text{MOE for dietary risk})}$$

$$= \frac{1}{(1 / 4) + (1 / 228)} = \mathbf{4}$$

"Z" and "AA": Seasonal and Annual MOE's for occupational re-entry

For most re-entry scenarios, calculation of seasonal and annual MOE's are equivalent to calculations for the short-term MOE's (which were shown above). Therefore, seasonal and annual calculations are not presented here. For all time periods, the **dermal NOEL is 14 mg / kg** (Rubin 2014, page 141, footnote "a" and page 117 text). For the Annual column, aggregate risks are shown contained within parentheses, calculated via the "hazard index" as for short-term risk (explained above). In contrast, for the Seasonal column, "no combined value appears for seasonal risk because such a value was not calculated for dietary exposure" (Rubin 2014, page 140, "Note").

For certain re-entry scenarios, such as "Asparagus hand harvesting," the columns for Seasonal and Annual are lined out (in other words, Table IV-7b does not present any values within Seasonal or Annual columns). The reason is, "seasonal, annual and lifetime exposures to carbaryl were not predicted for workers reentering treated asparagus, bean, blackberry, cabbage or tobacco fields. In addition, such exposures were not predicted for turf maintenance reentry workers" (Rubin 2014, page 141, "Note"). Beauvais (2014) explains, "No seasonal, annual, or lifetime exposure estimates were prepared for workers reentering treated asparagus, beans, blackberry, cabbage, carrot, tobacco or turf. Infrequent carbaryl use is reported on these sites" (Beauvais 2014, page 70, footnote "a").

"AB": Oncogenic risk for occupational re-entry

Oncogenic risks <u>not</u> in parentheses:

Oncogenic risk = (human oncogenic potency) x (lifetime average daily dose) (Rubin 2014, page 139, footnote "d")

Because oncogenic risk is expressed as a risk, rather than as a safety margin (MOE), oncogenic risk becomes unacceptable as values grow <u>larger</u> (indicating more risk). "Risk values less than 10^{-6} (i.e., <1 excess cancer per one million individuals) are considered negligible" (Rubin 2014, page 134).

Human oncogenic potency = 9.72 x 10^{-3} mg/kg/day^{-1} (Rubin 2014, page 139, footnote "d"; and page 120). This is also referred to as the Multistage Cancer Slope Factor. As summarized in Rubin 2014 (pages 120-121), the potency value was calculated by Beauvais (2014) based on several mouse oncogenicity trials, especially Hamada (1993b) and a U.S. EPA-sponsored reanalysis of the pathology slides (U.S.EPA 2002b).

Lifetime average daily dose (LADD) values for reentry workers are taken from Table IV-2b in the RCD (Rubin 2014), which simply copies the LADD estimates that are presented in the Exposure Assessment (Beauvais 2014). Calculation of LADD is explained in section 2.2 of this Appendix.

Sample calculation: dermal oncogenic risk for apple hand thinning reentry workers:

Oncogenic risk = (human oncogenic potency) x (dermal LADD from Table IV-2b)

= ($9.72x10^{-3}$ mg/kg/day^{-1}) x (0.276 mg/kg/day)

= **$2.68x10^{-3}$ excess cancer cases**

Oncogenic risks enclosed in parentheses:

"The aggregate oncogenic risk was the sum of the dermal oncogenic risk and the **dietary risk value of $3.68x10^{-6}$** for the Western USA (DPR, 2010)," (quote is from Rubin 2014, page 140, "Note").

Sample calculation: aggregate oncogenic risk for apple hand thinning reentry workers:

Oncogenic risk = (dermal oncogenic risk from Table IV-7b) + (dietary oncogenic risk from DPR 2010)

= ($2.68x10^{-3}$ excess cancer cases) + ($3.68x10^{-6}$ excess cancer cases)

= **$2.68x10^{-3}$ excess cancer cases**

2.2 Calculations of absorbed exposure dose (STADD, LADD, etc.) for occupational re-entry

Table format: The first few rows of RCD Table IV-2b are reproduced below. Column labels (such as "AC" and "AD") have been added to help explain the calculations:

Table IV-2b. Occupational reentry exposure to carbaryl by the dermal route - short-term, seasonal, annual and lifetime estimates

Exposure scenario	STADD (mg/kg/day) **"AC"**	SADD (mg/kg/day) **"AD"**	AADD (mg/kg/day) **"AE"**	LADD (mg/kg/day) **"AF"**
Apple hand thinning	3.41	2.07	0.517	0.276
Asparagus hand harvesting	0.363			
Beans scouting	0.727			

"AC": Short-Term Absorbed Daily Dosage (STADD) for occupational re-entry

As explained by Beauvais (2014) on page 67, **STADD** for most occupational re-entry scenarios is calculated as follows:

STADD = [(dermal absorption) x (short-term DFR) x (transfer coefficient) x (exposure duration)] / (70 kg body weight)

where DFR = dislodgeable foliar residue.

In contrast, for the turf maintenance scenario, STADD was estimated from a surrogate exposure monitoring study (Rosenheck and Sanchez 1995) that used the herbicide oxadiazon (Beauvais 2014, page 68, footnote "d").

Values of **transfer coefficients** and **short-term DFR** are listed in Table 30 of Beauvais (2014). The original sources of those values are listed in Table A5-2 later in this Appendix. For the remaining parameters used to calculate STADD for re-entry, Beauvais (2014) used the following assumptions (page 68, footnote "c"):

- **dermal absorption** = 70% (Beauvais, 2006a);
- **body weight** = 70 kg (Thongsinthusak et al., 1993); and
- **exposure duration** of 8 hours.

Re-entry exposure dosage estimates are for dermal route only, as the inhalation route was assumed to be insignificant for re-entry workers (Beauvais 2014, page 68, footnote "c"). Occupational re-entry exposure estimates were based on an assumption that re-entry

workers would use no protective clothing or equipment, "because a lot of reentry work occurs in hot weather and for several hours each day" (Beauvais 2014, pp. 67-68).

Sample calculation: dermal STADD for apple hand thinning re-entry:

STADD = [(dermal absorption) x (short-term DFR) x (transfer coefficient) x (exposure duration)] / (70 kg body weight)

= [(70%) x (14.2 µg/cm^2) x (0.001 mg/µg) x (3,000 cm^2/hour) x (8 hours/day)] / 70 kg

= 3.41 mg/kg/day

"AD": Seasonal Absorbed Daily Dosage (SADD) for occupational re-entry

The formula used to calculate SADD for occupational re-entry is equivalent to the STADD formula, except that it uses long-term DFR values listed in Table 31 of Beauvais (2014). The remaining parameters, such as exposure durations per day, are the same as for STADD (Beauvais 2014, page 70, footnote "d").

Sample calculation: dermal SADD for apple hand thinning re-entry:

SADD = [(dermal absorption) x (long-term DFR) x (transfer coefficient) x (exposure duration)] / (70 kg body weight)

= [(70%) x (8.62 µg/cm^2) x (0.001 mg/µg) x (3,000 cm^2/hour) x (8 hours/day)] / 70 kg

= 2.07 mg/kg/day

"AE": Annual Average Daily Dosage (AADD) for occupational re-entry

As explained by Beauvais (2014) on page 70 footnote "e", AADD for re-entry is calculated from SADD as follows:

AADD = SADD x (annual use months per year) / (12 months in a year).

Annual use is based on California's high-use period of 3 months (Beauvais 2014, page 53, footnote "c").

Sample calculation, apple hand thinning re-entry (corresponding to the first row of Table 31 in Beauvais 2014):

AADD = SADD (dermal) x (annual use months per year) / (12 months in a year).

= (2.07 mg / kg / day) x (3 months of use) / (12 months per year)

= 0.517 mg/kg/day

"AF": Lifetime Average Daily Dosage (LADD) for occupational re-emtry

As explained by Beauvais (2014) on page 70 footnote "f", **LADD** for occupational re-entry is calculated from AADD as follows:

LADD = AADD x (40 years of work in a lifetime) / (75 years in a lifetime)

Sample calculation, apple hand thinning (corresponding to the first row of Table 31 in Beauvais 2014):

LADD = AADD x (40 years of work in a lifetime) / (75 years in a lifetime)
= (0.517 mg/kg/day) x (40 years) / (75 years)
= **0.276 mg/kg/day**

2.3 Sources of transfer coefficient (TC) and dislodgeable foliar residue (DFR) values for occupational re-entry

For most occupational reentry scenarios, absorbed exposure doses were calculated from the parameters TC and DFR. Values of those parameters are listed in Table 30 and Table 31 of Beauvais (2014). The original sources of those values are listed in Table A5-2 below. For some scenarios, DFR had to be extrapolated from studies conducted on other use sites. For example, for asparagus hand-harvesting, Beauvais (2014) used DFR data from apple. Prior to undertaking mitigation activities, it may be useful for DPR to confirm how well those extrapolations match DFR concentrations within the actual use site of each scenario.

For one scenario, turf maintenance, exposure dose was estimated from monitoring turf re-entry exposure to a surrogate: the herbicide oxadiazon (Rosenheck and Sanchez 1995).

Table A5-2. Occupational Re-entry scenarios: Sources of the absorbed exposure doses in RCD Table IV-2b, which in turn were used for risk calculations in RCD Table IV-7b

Exposure scenario	**Source of absorbed exposure doses** (DFR = dislodgeable foliar residue, TC = transfer coefficient)	**Citation to document the source (within Beauvais 2014)**
Apple hand-thinning	Exposure dose calculated using: • DFR data from apple (Klonne et al. 2001c); and	Table 16, column "DFR from Crop"
	• TC from Frank (2009b)	Table 30, footnote "b"
Asparagus hand-harvesting	Exposure dose calculated using: • DFR data from apple (Klonne et al. 2001c); and	Table 16, column "DFR from Crop"
	• TC from Arthur (2005)	Table 30, footnote "b"
Beans scouting	Exposure dose calculated using: • DFR data from strawberry (Zweig et al. 1984); and	Table 16, column "DFR from Crop"
	• TC from Frank (2009b)	Table 30, footnote "b"
Blackberry pruning	Exposure dose calculated using: • DFR data from strawberry (Zweig et al. 1984); and	Table 16, column "DFR from Crop"
	• TC from Frank (2009b)	Table 30, footnote "b"
Cabbage scouting	Exposure dose calculated using: • DFR data from cabbage (Klonne et al. 2001a); and	Table 16, column "DFR from Crop"
	• TC from Frank (2009b)	Table 30, footnote "b"
Citrus pruning	Exposure dose calculated using: • DFR data from orange (Klonne and Merricks 2000); and	Table 16, column "DFR from Crop"
	• TC from Frank (2009b)	Table 30, footnote "b"

(continued next page)

Table A5-2. Occupational Re-entry scenarios: Sources of absorbed exposure doses (cont.)

Exposure scenario	**Source of parameters** (DFR = dislodgeable foliar residue, TC = transfer coefficient)	**Citation to document the source (within Beauvais 2014)**
Corn detasseling	Exposure dose calculated using: • DFR data from apple (Klonne et al. 2001c); and	Table 16, column "DFR from Crop"
	• TC from Frank (2009b)	Table 30, footnote "b"
Cucumber scouting	Exposure dose calculated using: • DFR data from cucumber (Klonne et al. 2001b); and	Table 16, column "DFR from Crop"
	• TC from Frank (2009b)	Table 30, footnote "b"
Grape leaf pulling	Exposure dose calculated using: • DFR data from strawberry (Zweig et al. 1984); and	Table 16, column "DFR from Crop"
	• TC from Frank (2009b)	Table 30, footnote "b"
Lettuce scouting	Exposure dose calculated using: • DFR data from apple (Klonne et al. 2001c); and	Table 16, column "DFR from Crop"
	• TC from Frank (2009b)	Table 30, footnote "b"
Olive pruning	Exposure dose calculated using: • DFR data from olive (Klonne et al. 2000a); and	Table 16, column "DFR from Crop"
	• TC from Klonne et al. (2000a)	Table 30, footnote "b"
Ornamental plant hand-harvesting	Exposure dose calculated using: • DFR data from orange (Klonne and Merricks 2000); and	Table 16, column "DFR from Crop"
	• TC from Klonne et al. (2000d)	Table 30, footnote "b"
Potato scouting	Exposure dose calculated using: • DFR data from strawberry (Zweig et al. 1984); and	Table 16, column "DFR from Crop"
	• TC from Frank (2009b)	Table 30, footnote "b"
Strawberry scouting	Exposure dose calculated using: • DFR data from strawberry (Zweig et al. 1984); and	Table 16, column "DFR from Crop"
	• TC from Frank (2009b)	Table 30, footnote "b"
Tobacco hand-harvesting	Exposure dose calculated using: • DFR data from tobacco (Klonne et al. 1999a); and	Table 16, column "DFR from Crop"
	• TC from Frank (2009b)	Table 30, footnote "b"
Tomato staking / tying	Exposure dose calculated using: • DFR data from strawberry (Zweig et al. 1984); and	Table 16, column "DFR from Crop"
	• TC from Frank (2009b)	Table 30, footnote "b"
Turf maintenance	Exposure estimated from surrogate exposure monitoring (Rosenheck and Sanchez 1995)	Table 30, footnote "d"

3. Residential Handler and Residential Reentry scenarios (risk calculations in RCD Table IV-8)

3.1 Calculations of risk (MOE's) for residential handler and re-entry

Table format: Selected rows of RCD Table IV-8 are reproduced below. Column labels (such as "AG" and "AL") have been added to help explain the calculations. Regarding the table format, "Only short-term uses were anticipated for residential handler scenarios; consequently, there were no SADD, AADD or LADD estimates" (Rubin 2014, page 149, "Note").

Table IV-8. Residential handler and residential turf reentry risks from exposure to carbaryl by the dermal and inhalation routes – short-term margins of exposure

Exposure scenario	Short-term MOEs		
	Dermal **"AG"**	Inhalation **"AH"**	Aggregate **"AI"**
Residential handlers			
Backpack mixer / loader / applicator	86	5495	85 (62)
Low pressure handwand mixer / loader / applicator	1768	18,692	1615 (200)
Residential reentry onto carbaryl-treated turf	**"AJ"**	**"AK"**	**"AL"**
Adults	5		5 (5)
Toddlers	3		3 (3)

"AG" Dermal short-term MOE for residential handlers

MOE = NOEL / exposure dose (Rubin 2014, page 134). An example of "exposure dose" is Short-Term Absorbed Daily Dosage (STADD).

NOEL for acute dermal exposure = **14 mg / kg** (Rubin 2014, page 142, footnote "b")

Exposure dose estimates for residential applicator exposure are taken from Table IV-3 in the RCD (Rubin 2014), which simply copies the estimates of absorbed dose that are presented in the Exposure Assessment (Beauvais 2014). Calculation of exposure doses is explained in section 3.2 of this Appendix.

Sample risk calculation, short-term dermal MOE for residential backpack mixer / loader / applicator:

MOE = NOEL / exposure dose = (14 mg/kg) / (STADD from Table IV-3) = (14 mg/kg) / (0.163 mg/kg/day) = **86**

"AH" Inhalation short-term MOE's for residential handlers

MOE = NOEL / exposure dose (Rubin 2014, page 134). An example of "exposure dose" is Short-Term Absorbed Daily Dosage (STADD).

NOEL for acute inhalation exposure = **1 mg / kg** (Rubin 2014, page 142, footnote "c")

Exposure dose estimates for residential applicator exposure are taken from Table IV-3 in the RCD (Rubin 2014), which simply copies the estimates of absorbed dose that are presented in the Exposure Assessment (Beauvais 2014). Calculation of exposure doses is explained in section 3.2 of this Appendix.

Sample risk calculation, short-term inhalation MOE for residential backpack mixer / loader / applicator:

MOE = NOEL / exposure dose = (1 mg/kg) / (STADD from Table IV-3) = (1 mg/kg) / (0.000182 mg/kg/day) = **5495**

"AI" Aggregate short-term MOE's for residential handlers

Aggregate MOE's <u>not</u> in parentheses:

> **MOE: "**The combined non-oncogenic risk for acute exposures were calculated by the 'hazard index' approach, which was equal to the inverse of the sum of the inverses of the contributory MOE values" (Rubin 2014, page 143, footnote "d"). In other words, for aggregate MOE's within Table IV-8 that are <u>not</u> enclosed in parentheses:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{“AG”}) + (1 / \text{“AH”})}$$

Sample risk calculation, aggregate MOE <u>not</u> including dietary risk for residential backpack mixer / loader / applicator:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{“AG”}) + (1 / \text{“AH”})} = \frac{1}{(1 / 86) + (1 / 5495)} = \mathbf{85}$$

Aggregate MOE's enclosed within parentheses:

MOE: "Parenthetic values represent the risk when acute dietary exposure is also considered" (Rubin 2014, page 143, footnote "d"). The aggregate acute MOE assumed a Monte Carlo-derived, 99.9% percentile **dietary acute MOE of 228** for working adults (DPR, 2010), based on the acute oral NOEL of 1 mg/kg" (Rubin 2014, page 138, footnote "c").

In other words, for values within parentheses:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{“AG”}) + (1 / \text{“AH”}) + (1 / \text{dietary MOE})}$$

Sample calculation, aggregate MOE <u>including</u> dietary risk for residential backpack mixer / loader / applicator:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{“AG”}) + (1 / \text{“AH”}) + (1 / \text{dietary MOE})}$$

$$= \frac{1}{(1 / 86) + (1 / 5495) + (1 / 228)} = \mathbf{62}$$

"AJ" Dermal short-term MOE for residential reentry onto treated turf

MOE = NOEL / exposure dose (Rubin 2014, page 134). An example of "exposure dose" is STADD.

NOEL for acute dermal exposure = **14 mg / kg** (Rubin 2014, page 142, footnote "b")

Exposure dose estimates for residential applicator exposure are taken from Table IV-3 in the RCD (Rubin 2014), which simply copies the estimates of absorbed dose that are presented in the Exposure Assessment (Beauvais 2014). Calculation of exposure doses is explained in section 3.2 of this Appendix.

Sample risk calculation, short-term dermal MOE for adult residential reentry onto treated turf:

MOE = NOEL / exposure dose = (14 mg/kg) / (STADD from Table IV-3) = (14 mg/kg) / (2.58 mg/kg/day) = **5**

"AK" Inhalation short-term MOE's for residential reentry onto treated turf

Corresponding cells within Table IV-8 are lined out (in other words, Table IV-8 does not provide any values). The reason is, "Significant inhalation exposure upon reentry to turf previously treated with carbaryl was considered to be unlikely" (Rubin 2014, page 129, footnote "b").

"AL" Aggregate short-term MOE's for residential reentry

Aggregate MOE's <u>not</u> in parentheses:

Because no MOE's were calculated for inhalation, the aggregate MOE is simply equal to the dermal MOE (equal to "AJ").

Aggregate MOE's enclosed within parentheses:

MOE: "Parenthetic values represent the risk when acute dietary exposure is also considered" (Rubin 2014, page 143, footnote "d"). The aggregate acute MOE assumed a Monte Carlo-derived, 99.9% percentile **dietary acute MOE of 228** for working adults (DPR, 2010), based on the acute oral NOEL of 1 mg/kg" (Rubin 2014, page 138, footnote "c").

In other words, for values within parentheses:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{“AJ”}) + (1 / \text{dietary MOE})}$$

Sample calculation, aggregate MOE <u>including</u> dietary risk for adult residential reentry onto treated turf:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{“AJ”}) + (1 / \text{dietary MOE})}$$

$$= \frac{1}{(1 / 5) + (1 / 228)} = \mathbf{5}$$

3.2 Calculations of absorbed exposure dose (STADD)

Table format: Selected rows of RCD Table IV-3 are reproduced below. Column labels (such as "AM" and "AR") have been added to help explain the calculations. Regarding the table format, "Only short-term uses were anticipated for residential handler scenarios; consequently, there were no SADD, AADD or LADD estimates" (Rubin 2014, page 149, "Note").

Table IV-3. Residential handler and residential turf reentry exposure to carbaryl by the dermal and inhalation routes – short-term estimates

Exposure scenario	STADD (mg/kg/day)		
	Dermal **"AM"**	Inhalation **"AN"**	Aggregate **"AO"**
Residential handlers (Beauvais 2014, Table 32)			
Backpack mixer / loader / applicator	0.163	0.000182	0.163
Low pressure handwand mixer / loader / applicator	0.00792	0.0000535	0.00794
Residential reentry onto carbaryl-treated turf (Beauvais 2014, Table 33)	**"AP"**	**"AQ"**	**"AR"**
Adults	2.58		2.58
Toddlers	4.33		4.33

"AM": Dermal Short-Term Absorbed Daily Dosage (STADD) for residential handlers

As explained by Beauvais (2014) on pages 79-80, dermal **STADD** for most residential handler scenarios is calculated as follows:

STADD = [(AI applied per day) x (exposure rate) x (dermal absorption)] / (70 kg body weight)

Values of **exposure rates** are listed in Table 32 of Beauvais (2014). The original sources of those values are listed in Table A5-3 later in this Appendix. For the remaining parameters used to calculate STADD for residential handlers, Beauvais (2014) used the following assumptions (page 80, footnote "c"):

- **dermal absorption** = 70% (Beauvais, 2006a);
- **body weight** = 70 kg (Thongsinthusak et al., 1993); and

- **Active ingredient (AI) applied per day** depends on the scenario, and assumes:
  - application of **0.19 lb AI/1000 ft^2 of lawn** (LPHW, backpack, and hose-end sprayers); **or**
  - one 32-ounce bottle per day (0.946 liters/day), containing **0.00263 lb AI (0.00119 kg AI) on 1000 ft^2 of ornamentals** (trigger spray); **or**
  - **0.1 lb AI/day (dust**; equivalent to one can); **or**
  - **8.28 lbs AI/acre on a 0.5 acre lawn** (push-type spreader) (Beauvais 2014, page 80, footnote "c").

Sample calculation: dermal STADD for residential backpack mixer / loader / applicator:

STADD = [(AI applied per day) x (exposure rate) x (dermal absorption)] / (70 kg body weight)

= [(0.19 lb AI/day) x (85,637 µg/lb AI) x (0.001 mg/µg) x (0.70 dermal absorption)] / 70 kg

= 0.163 mg/kg/day

"AN": Inhalation Short-Term Absorbed Daily Dosage (STADD) for residential handlers

As explained by Beauvais (2014) on pages 79-80, inhalation **STADD** for most residential handler scenarios is calculated as follows:

STADD = [(AI applied per day) x (exposure rate) x (inhalation absorption)] / (70 kg body weight)

Values of **exposure rates** are listed in Table 32 of Beauvais (2014). The original sources of those values are listed in Table A5-3 later in this Appendix. For the remaining parameters, assumptions are the same as those listed above for dermal STADD, except that inhalation absorption = 100% (Frank 2008).

Sample calculation: inhalation STADD for residential backpack mixer / loader / applicator:

STADD = [(AI applied per day) x (exposure rate) x (inhalation absorption)] / (70 kg body weight)

= [(0.19 lb AI/day) x (67.1 µg/lb AI) x (0.001 mg/µg) x (1.00 dermal absorption)] / 70 kg

= 1.82x10^{-4} mg/kg/day

"AO": Aggregate Short-Term Absorbed Daily Dosage (STADD) for residential handlers

Aggregate STADD is simply the sum of dermal plus inhalation STADD's.

Sample calculation: aggregate STADD for residential backpack mixer / loader / applicator:

STADD = [(dermal STADD) + (inhalation STADD)]
= [(0.163 mg/kg/day) + (1.82×10^{-4} mg/kg/day)] = **0.163 mg/kg/day**

"AP": Dermal Short-Term Absorbed Daily Dosage (STADD) for residential reentry to treated turf

Calculation of STADD for residential reentry is explained in detail in Beauvais (2014), pages 82-83, and thus is not repeated here. Briefly, adult exposure rate (in µg/kg/hour) was measured during a study of volunteers simulating reentry to (i.e., performing a Jazzercise® routine on) turf that had been treated with a surrogate: the herbicide oxadiazon (Rosenheck and Sanchez 1995). Beauvais (2014) multiplied oxadiazon exposure rate by a constant to adjust for the higher maximum application rate of carbaryl, then calculated the 95th percentile carbaryl exposure rate. STADD calculation assumptions included:

- 70% dermal absorption (Beauvais, 2006a); and
- Adults are on treated residential turf for 2 hours per day (U.S. EPA 1997b).

For toddlers, exposure rate for residential reentry was calculated from adult exposure rate by:

- Multiplying by the ratio of mean body weights (69.4 kg adults / 15.0 kg toddlers); and
- Dividing by the adult / toddler ratio of assumed body surface areas (18150 cm^2 adult / 6565 cm^2 toddler).

As for adults, the assumption when calculating toddler STADD was that toddlers are on treated residential turf for 2 hours per day. Calculations are clearly illustrated in Beauvais 2014 (pages 82-83).

"AQ" Inhalation STADD for residential reentry onto treated turf

Corresponding cells within Table IV-3 are lined out (in other words, Table IV-3 does not provide any values). The reason is, "Significant inhalation exposure upon reentry to turf previously treated with carbaryl was considered to be unlikely" (Rubin 2014, page 129, footnote "b").

"AR" Aggregate STADD for residential reentry

Because no MOE's were calculated for inhalation, the aggregate STADD is simply equal to the dermal STADD (equal to "AP").

3.3 Sources of exposure rate estimates

For most residential handler scenarios, exposure rates (in µg AI / kg AI handled) were estimated from carbaryl exposure monitoring studies. For some scenarios, exposure rates were estimated from surrogate monitoring studies or from the PHED database.

For residential reentry scenarios, adult exposure rate (in µg AI / kg body weight / hour of reentry duration) was calculated from surrogate monitoring studies. Toddler exposure rate was calculated from adult exposure rate. For more details, see Table A5-3 below.

Table A5-3 Residential Re-entry scenarios: Sources of exposure rates used to calculate absorbed exposure doses in RCD Table IV-3, which in turn were used for risk calculations in RCD Table IV-8

Exposure scenario	Source of exposure rate	Citation to document the source (within Beauvais 2014)
Residential handler scenarios (risk calculations in RCD Table IV-8)		
Backpack M / L / A	Exposure rate estimated from PHED database. For details of estimation procedures, see Beauvais 2014 Appendix 3.	Table 32, footnote "c"
Low-pressure handwand (a.k.a. hand-pumped sprayer) M / L / A	Exposure rate estimated (95th percentile) from carbaryl exposure monitoring study (Merricks 1997). For estimation procedures, see Beauvais (2011a).	Table 20, footnote "b" and Table 32, footnote "d"
Trigger spray applicator, for ready-to-use liquid		
Hose-end sprayer M/L/A		
Dust loader / applicator		
Push-type spreader for granules M / L / A	Exposure rate calculated from exposure monitoring study of a surrogate, the herbicide dimethyl tetrachloroterephthalate (Klonne and Honeycutt 1999). For calculation procedures, see Beauvais (2011b).	Table 20, footnote "f"
Residential turf reentry scenarios (risk calculations in RCD Table IV-8)		
Adults	Exposure rate calculated from exposure monitoring study of a surrogate, the herbicide oxadiazon (Rosenheck and Sanchez 1995). For calculation procedures, see Beauvais (2012).	Table 33, footnote "c"
Toddlers	Exposure rate calculated from adult estimated exposure rate. For calculation procedure, see Beauvais (2014) pages 82 – 83.	Table 33, footnote "c"

4. Bystander scenarios (risk calculations in RCD Table IV-11)

4.1 Calculations of risk (MOE's and oncogenic risk) for bystanders

Table format: The entire RCD Table IV-11 is reproduced below. Because the table format is relatively simple, no additional column labels have been added. Calculations for each of the seven risk categories (seven rows of the table) are explained below the table.

Table IV-11. Non-oncogenic and oncogenic risks resulting from inhalational carbaryl exposure to bystanders – agricultural and public pest control applications

	MOE
Bystander exposure, agricultural applications	
1-hr risk (heavy activity)	
Infant	91 (46)
Adult	505 (157)
Short-term risk	
Infant	52 (33)
Adult	110 (74)
Seasonal risk	
Infant	107
Adult	224
Annual risk	
Infant	1279 (86)
Adult	2688 (210)
Lifetime oncogenic risk	
Infant	n/a
Adult	1.81×10^{-6} (5.49×10^{-6})
Bystander exposure, public pest control programs	
1-hr risk (heavy activity)	
Infant	333 (72)
Adult	1852 (203)
Short-term risk	
Infant	6667 (91)
Adult	37,037 (227)

1-hr risk (heavy activity) for bystanders, agricultural applications

1-hr risk <u>not</u> in parentheses:

MOE = NOEL / exposure dose (Rubin 2014, page 134). An example of "exposure dose" is STADD.

NOEL for acute inhalation exposure = **1 mg / kg** (Rubin 2014, page 147, footnote "a")
Exposure dose estimates for bystander exposure are taken from Table IV-6 in the RCD (Rubin 2014), which simply copies the estimates of absorbed dose that are presented in the Exposure Assessment (Beauvais 2014, Table 35). Calculation of exposure doses is explained in section 4.2 of this Appendix.

Sample risk calculation, <u>infant</u> bystander 1-hr risk (heavy activity) for agricultural applications:

MOE = NOEL / exposure dose

= (1 mg/kg) / (1-hr absorbed dose from Table IV-6)

= (1 mg/kg) / (0.0110 mg/kg/hr) = **91**

1-hr risk enclosed in parentheses:

MOE: As explained by Rubin (2014) page 147 "Note", "Aggregate MOEs were calculated by adding exposure from dietary sources using the hazard index approach as described in Table IV-7a above. The acute **dietary MOE for children** 1-2 yr at the 99.9th percentile using the Monte Carlo approach **was 92**, while that **for adults** 16-70 years **was 228** (DPR, 2010)".

In other words, for values within parentheses:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{inhalation MOE}) + (1 / \text{acute dietary MOE})}$$

Sample calculation, aggregate MOE including dietary risk for <u>infant</u> bystander 1-hr risk (heavy activity) for agricultural applications:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{inhalation MOE}) + (1 / \text{infant acute dietary MOE})}$$

$$= \frac{1}{(1 / 91) + (1 / 92)} = \mathbf{46}$$

Short-term risk for bystanders, agricultural applications

Short-term risk <u>not</u> in parentheses:

MOE = NOEL / exposure dose (Rubin 2014, page 134). For short-term risk, "exposure dose" is STADD.

NOEL for acute inhalation exposure = **1 mg / kg** (Rubin 2014, page 147, footnote "a")

Exposure dose estimates for bystander exposure are taken from Table IV-6 in the RCD (Rubin 2014), which simply copies the estimates of absorbed dose that are presented in the Exposure Assessment (Beauvais 2014, Table 35). Calculation of exposure doses is explained in section 4.2 of this Appendix.

Sample risk calculation, <u>infant</u> bystander short-term risk for agricultural applications:

MOE = NOEL / exposure dose

= (1 mg/kg) / (STADD from Table IV-6)

= (1 mg/kg) / (0.0192 mg/kg/hr) = **52**

Short-term risk enclosed in parentheses:

MOE: As explained by Rubin (2014) page 147 "Note", "Aggregate MOEs were calculated by adding exposure from dietary sources using the hazard index approach as described in Table IV-7a above. The acute **dietary MOE for children** 1-2 yr at the 99.9th percentile using the Monte Carlo approach **was 92**, while that **for adults** 16-70 years **was 228** (DPR, 2010)".

In other words, for values within parentheses:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{inhalation MOE}) + (1 / \text{acute dietary MOE})}$$

Sample calculation, aggregate MOE including dietary risk for <u>infant</u> bystander short-term risk for agricultural applications:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{inhalation MOE}) + (1 / \text{infant acute dietary MOE})}$$

$$= \frac{1}{(1 / 52) + (1 / 92)} = \mathbf{33}$$

Seasonal inhalation risk for bystanders, agricultural applications

Note: unlike for other risk categories, for seasonal risk Table IV-11 does not present values for aggregate risk (inhalation plus dietary risk). "No combined value appears for seasonal risk because such a value was not calculated for dietary exposure" (Rubin 2014, page 140, "Note").

MOE = NOEL / exposure dose (Rubin 2014, page 134). For seasonal risk, "exposure dose" is SADD.

NOEL for subchronic and chronic inhalation exposure = **0.5 mg / kg** (Rubin 2014, page 147, footnote "b")

Exposure dose estimates for bystander exposure are taken from Table IV-6 in the RCD (Rubin 2014), which simply copies the estimates of absorbed dose that are presented in the Exposure Assessment (Beauvais 2014, Table 35). Calculation of exposure doses is explained in section 4.2 of this Appendix.

Sample risk calculation, infant bystander seasonal risk for agricultural applications:

MOE = NOEL / exposure dose

= (0.5 mg/kg) / (SADD from Table IV-6)

= (0.5 mg/kg) / (0.00469 mg/kg/hr) = **107**

Annual risk for bystanders, agricultural applications

Annual risk not in parentheses:

MOE = NOEL / exposure dose (Rubin 2014, page 134). For annual risk, "exposure dose" is Annual Absorbed Daily Dosage (AADD).

NOEL for subchronic and chronic inhalation exposure = **0.5 mg / kg** (Rubin 2014, page 147, footnote "b")

Exposure dose estimates for bystander exposure are taken from Table IV-6 in the RCD (Rubin 2014), which simply copies the estimates of absorbed dose that are presented in the Exposure Assessment (Beauvais 2014, Table 35). Calculation of exposure doses is explained in section 4.2 of this Appendix.

Sample risk calculation, infant bystander annual risk for agricultural applications:

MOE = NOEL / exposure dose

= (0.5 mg/kg) / (AADD from Table IV-6)

= (0.5 mg/kg) / (0.000391 mg/kg/hr) = **1,279**

Annual risk enclosed in parentheses [within RCD Table IV-11]:

MOE: As for short-term exposures, "Aggregate MOEs were calculated by adding exposure from dietary sources using the hazard index approach" (Rubin 2014, page 147, "Note"). However, for annual risk, "The aggregate chronic MOE assumed a **chronic dietary MOE of 1973 for adults**, 20-49 years old (DPR, 2010)". The quote is from Rubin 2014, pages 140-141, "Note".

Although not explicitly stated, the values within Table IV-11 indicate that the aggregate annual MOE was calculated using the **acute dietary MOE.** Specifically, the acute dietary MOE's were the 99.9% Monte Carlo values for "All enfants" or "M/F 16-70 yr" within DPR 2010 Table IV-5.

In other words, for annual risk values within parentheses:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{inhalation MOE}) + (1 / \text{acute dietary MOE})}$$

Sample calculation, aggregate MOE including dietary risk for infant bystander annual risk for agricultural applications:

$$\text{Aggregate MOE} = \frac{1}{(1 / \text{inhalation MOE}) + (1 / \text{infant acute dietary MOE})}$$

$$= \frac{1}{(1 / 1279) + (1 / 92)} = \mathbf{86}$$

Calculation of the adult bystander annual risk for agricultural applications uses the same formula, substituting the adult acute dietary MOE of 228 (DPR 2010 Table IV-5).

Lifetime oncogenic risk for bystanders, agricultural applications

Lifetime oncogenic risk <u>not</u> in parentheses:

Risk value: For adults, "Oncogenic risk was calculated as the product of the **potency value, 9.72x10-3 mg/kg/day^{-1}**, and the **lifetime average daily dose** in mg/kg/day. As such, it is a unitless value. (Rubin 2014, page 134)" (Rubin 2014, page 147, footnote "c").

In contrast, "Oncogenic risk to infants was not calculated because DPR assumes that a lifetime of exposure underlies cancer development" (Rubin 2014, page 146).

Lifetime average daily dose (LADD) values for bystanders are taken from Table IV-6 in the RCD (Rubin 2014), which simply copies the LADD estimates that are presented in the Exposure Assessment (Beauvais 2014). Calculation of LADD is explained in section 4.2 of this Appendix.

Sample calculation: <u>adult</u> lifetime oncogenic risk for bystanders from agricultural applications:

Oncogenic risk = (human oncogenic potency) x (adult LADD from Table IV-6)

= $(9.72 \times 10^{-3}$ mg/kg/day$^{-1})$ x (0.000186 mg/kg/day)

= **1.81×10^{-6} excess cancer cases**

Lifetime oncogenic risk enclosed in parentheses:

For adults, "The aggregate oncogenic risk to bystanders of agricultural applications was calculated by adding the dietary risk value of 3.68×10^{-6} to the value of 1.81×10^{-6} due to inhalation exposure" (Rubin 2014, page 147, "Note").

In contrast, "Oncogenic risk to infants was not calculated because DPR assumes that a lifetime of exposure underlies cancer development" (Rubin 2014, page 146).

Risks for bystanders from public pest control programs

1-hr and Short-term risks are calculated in the same manner as for agricultural applications (explained earlier in this Appendix), substituting the corresponding absorbed doses for public pest control programs from Table IV-6.

4.2 Calculations of absorbed exposure dose (STADD, LADD, etc.) for bystanders

Table format: The entire RCD Table IV-6 is reproduced below. Because the table format is relatively simple, no additional column labels have been added. Calculations for each of the seven exposure categories (seven rows of the table) are explained below the table.

Table IV-6. Carbaryl exposure to bystanders resulting from agricultural and public pest control applications

	Absorbed dose
Bystander exposure, agricultural applications (Beauvais 2014, Table 35)	
1-hr absorbed dose (heavy activity) Infant Adult	 0.0110 mg/kg/hr 0.00198 mg/kg/hr
Short-term absorbed daily dosage (STADD) Infant Adult	 0.0192 mg/kg/day 0.00910 mg/kg/day
Seasonal absorbed daily dosage (SADD) Infant Adult	 0.00469 mg/kg/day 0.00223 mg/kg/day
Annual absorbed daily dosage (AADD) Infant Adult	 0.000391 mg/kg/day 0.000186 mg/kg/day
Lifetime absorbed daily dosage (LADD) Infant Adult	 n/a 0.000186 mg/kg/day
Bystander exposure, public pest control programs (Beauvais 2014, Table 36)	
1-hr absorbed dose (heavy activity) Infant Adult	 0.0030mg/kg/hr 0.00054 mg/kg/hr
Short-term absorbed daily dosage (STADD) Infant Adult	 0.00015 mg/kg/day 0.000027 mg/kg/day

1-hr absorbed dose (heavy activity), agricultural applications

Dose calculation: As explained by Beauvais 2014 (page 86, footnote "d"),
1-hour absorbed dose (mg/kg/hour) = (highest 1-hour air concentration) x (inhalation rate)

Air concentrations ($\mu g/m^3$) depend on the duration for which the dosage is being calculated, and are tabulated in Beauvais (2014) Table 35. The original sources of those values is discussed in section 4.3 of this Appendix.

Inhalation rates (m^3/kg/hr) likewise depend on the duration for which the dosage is being calculated, and are tabulated in Beauvais (2014) Table 35. The original sources of those values is discussed in section 4.3 of this Appendix.

Sample calculation, infant bystander 1-hr absorbed dose from agricultural applications:

1-hour absorbed dose = (highest 1-hour air concentration) x (inhalation rate)

= (43.9 µg/m^3) x (0.001 mg/µg) x (0.25 m^3/kg/hour)

= 0.011 mg/kg/hr

STADD, agricultural applications

STADD: As explained by Beauvais 2014 (page 86, footnote "e"),

STADD (mg/kg/day) = (TWA short-term air concentration) x (inhalation rate)
where TWA = time-weighted average based on air monitoring of an airblast application of a surrogate chemical, methyl parathion.

Air concentrations (µg/m^3) depend on the duration for which the dosage is being calculated, and are tabulated in Beauvais (2014) Table 35. The original sources of those values is discussed in section 4.3 of this Appendix.

Inhalation rates (m^3/kg/hr) likewise depend on the duration for which the dosage is being calculated, and are tabulated in Beauvais (2014) Table 35. The original sources of those values is discussed in section 4.3 of this Appendix.

Sample calculation, infant bystander STADD from agricultural applications:

STADD = (TWA short-term air concentration) x (inhalation rate)

= (32.5 µg/m^3) x (0.001 mg/µg) x (0.59 m^3/kg/day)

= 0.0192 mg/kg/day

SADD, agricultural applications

SADD: As explained by Beauvais 2014 (page 86, footnote "f"),

STADD (mg/kg/day) = (TWA seasonal air concentration) x (inhalation rate)

Air concentrations (µg/m^3) depend on the duration for which the dosage is being calculated, and are tabulated in Beauvais (2014) Table 35. In addition, Beauvais explained:

> "There is a step in that calculation that I failed to explain in Table 35 or the surrounding text of the EAD. 1.59 was the concentration reported by Wofford and Ando for methyl parathion applied at 2 lbs AI/acre. For the seasonal and annual exposures, I assumed the mean application rate reported in the PUR for carbaryl ground applications to citrus over a 5-year interval as described in Appendix 4 (page 135) of the EAD. That was 10 lbs AI/acre. I therefore multiplied 1.59 by 5 = 7.95" (Sheryl Beauvais, personal communication, April 9, 2015).

Inhalation rates (m^3/kg/hr) likewise depend on the duration for which the dosage is being calculated, and are tabulated in Beauvais (2014) Table 35. The original sources of those values is discussed in section 4.3 of this Appendix.

Sample calculation, infant bystander SADD from agricultural applications:

SADD = (TWA seasonal air concentration) x (inhalation rate)

= (1.59 µg/m^3 x 5) x (0.001 mg/µg) x (0.59 m^3/kg/day)

= 0.00469 mg/kg/day

Annual absorbed daily dosage (AADD), agricultural applications

AADD: = (SADD) x (annual use months per year) / 12 months per year
where annual use is estimated at 1 month (Beauvais 2014, page 86, footnote "g").

Note that this 1-month estimate is shorter than California's high-use period of 3 months, which was used to calculate annual dosage for agricultural handlers (Beauvais 2014, page 53, footnote "c").

Sample calculation, infant bystander AADD from agricultural applications:

AADD = (SADD) x (annual use months per year) / 12 months per year

= (0.00469 mg/kg/day) x (1 month use / 12 months per year)

= 0.00391 mg/kg/day

Lifetime absorbed daily dosage (LADD), agricultural applications

For adults, LADD is equal to AADD, because ". . . average annual exposures occur each year over a lifetime for residential bystanders residing at the same location. Infants are a relatively small part of the assumed lifetime, and no separate lifetime estimates are calculated for them" (Beauvais 2014, page 86, footnote "h").

4.3 Sources of carbaryl air concentrations and inhalation rates for bystanders

Bystander absorbed doses, such as STADD, were calculated from two parameters:

1) Assumed carbaryl concentration in the air ($\mu g/m^3$); and
2) Inhalation rate of bystanders (m^3/kg/hour or m^3/kg/day).

Assumed carbaryl concentrations are tabulated in Beauvais (2014) Table 35, and are, "based on air monitoring done in 2003 during and following an airblast application of a surrogate chemical, methyl parathion, to a walnut orchard in San Joaquin County (Wofford and Ando, 2003; Barry, 2006). Concentrations were time-weighted averages (TWA) multiplied by the ratio of maximum allowed application rate on citrus of 12 lbs AI/acre (for short-term exposures), or the typical application rate on citrus of 10 lbs AI/acre (seasonal exposure) to the 2 lbs AI/acre rate used in the study monitored by Wofford and Ando (2003)" (Beauvais 2014, page 86, footnote "a").

Inhalation rates likewise are tabulated in Beauvais (2014) Table 35, and were estimated as follows. "Different inhalation rates were used for the 1-hour and daily absorbed doses. The inhalation rates for 1-hour absorbed dose estimates were calculated from values reported in Andrews and Patterson (2000), assuming heavy activity and dividing by the mean body weight for males and females (71.8 kg). Hourly inhalation rates for heavy activity are 1.9 m3/hour for infants (Layton, 1993; U.S. EPA, 1997a) and 3.2 m3/hour for adults (Wiley et al., 1991; U.S. EPA, 1997a; OEHHA, 2000). Daily inhalation rates are default values from Andrews and Patterson (2000)." (Beauvais 2014, page 86, footnote "b").